The Application of System Dynamics to Resource Allocation in International NGOs

Exploring and modelling power inequalities whilst increasing efficiencies in complex international NGO management systems

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Opinions, recommendations and conclusions expressed in this dissertation are those of the author and not necessarily those of the stakeholders who provided input into this study.

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Abstract

We are living in an unjust world where the majority of humanity is subject to unequal economic and public policy systems that perpetuate cycles of poverty. Civil society, of which international NGOs are major players, are acknowledging the need for systemic, transformational change, which has to include meaningful participation in decision making processes by those whom are most vulnerable.

In order to more effectively play this role, a number of international NGOs are moving decentralised structures (often comprised of independent entities at country level) to legitimately represent their primary constituents - those that are vulnerable, living in poverty, mostly in the global South.

A consequence of this trajectory is added internal complexity and the creation of new management challenges, as decision making processes become more participatory and transparent. In addition, this new reality of complex federal structures also requires that power inequities between entities, are openly acknowledged and managed. Despite these challenges, this is a non-negotiable journey for many international NGOs and they acknowledge the need to adapt their management mechanisms to better handle this internal complexity.

First-hand experience sparked the interest to apply operational research and system dynamics approaches to one such management mechanism, that of **resource planning and allocation within international NGOs**. This study aims to develop a set of insights, based on the system dynamics model, that could be useful to international NGO decision makers as they respond to their "real life" resource allocation challenges.

Problem structuring methods are applied to these resource allocation challenges to gain a deeper understanding of the core components of resource allocation in order to develop a generic system dynamics model that simulates the necessary behaviours based on stakeholder input. A set of management scenarios are developed and form the basis for conducting experimental runs on the generic system dynamics model, testing different parameters in an effort to compare quantitative results. These quantitative results are used to compare performance against the original generic model, analysing trends and model behaviour to inform qualitative recommendations and conclusions.

Key words: Resource Allocation, System Dynamics, Operational Research, International Non-Government Organisations (NGOs), Problem Structuring, Management Systems, Simulation.

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I would also like to thank the international NGO managers and professionals for their engagement during the stakeholder interview process. Their insightful contributions and input laid a critical foundation for this study. I hope this will spark further interest in the investment and application of such operational research and modelling approaches to tackle this and other complex management systems in the sector.

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Chapter 1

Introduction

1.1 Introduction

"Unprecedented efforts (to save the lives of millions and improved conditions for many more) have resulted in profound achievements... (however) despite many successes, the poorest and most vulnerable are being left behind." [United Nations, 2015]

The Organisation for Economic Co-operation and Development (OECD) has verified the upward trend of combined foreign aid and official development assistance for quite some time [OECD, 2016]. However, this increased financing, coupled with the first global development framework, the Millennium Development Goals[1], have displayed uneven, some say unsatisfactory, results [UnitedNations, 2015].

The degree of success and root causes of the shortcomings of such efforts are diverse and hotly contested but not the topic of this study. Rather, this reality illustrates the increasing complexity of sustainable development challenges and how these are perpetuated by unequal and discriminating policies and systems. This renders truth in the saying, *"the road to hell is paved with good intentions"*: sometimes no amount of money, human resource and good will can effect change without taking into account the holistic systems within which inequity and injustice thrives.

Various development actors are responding to these systemic challenges with increased emphasis on lobbying, policy and campaign agendas together with their more traditional development programmes. International NGOs are particularly well placed to influence such policy reform agendas, as their multi-country presence and accountability to the vulnerable amplifies the un/under-heard voices who historically get the raw end of the deal.

In order to play this role with increased legitimacy, some international NGOs are moving away from their traditional, typically Northern-centric structures (funded by and head-quartered in rich, developed countries) towards decentralised "federal" structures. Such decentralised federations are often comprised of independent entities at country level (to legitimately represent their own constituents), supported by federation decision making processes that are meaningfully participatory.

[1] It is premature to establsih the impact of their successors, the Sustainable Development Goals.

A consequence of this trajectory is added internal complexity and the creation of new management challenges. As in reality, collective decision making, especially when it comes to resourcing, can be lengthy and contentious, resulting in the adoption of complicated, cumbersome internal processes to increase participation and transparency. In addition, this new reality of complex federal structures also requires that power inequities between entities, are openly acknowledged and managed.

Despite these challenges, this is a non-negotiable journey for many international NGOs and they acknowledge the need to adapt their management mechanisms to better handle this internal complexity.

First-hand experience sparked the interest to apply operational research and system dynamics approaches to one such management mechanism, that of **resource planning and allocation within international NGOs**. The intention of this study is to investigate the extent to which such a modelling process can generate insights for NGO management in relation to their performance and effectiveness.

1.2 Purpose of the study

The desired outcome of this study is to develop a set of insights, based on the system dynamics model, that could be useful to international NGO decision makers as they respond to their "real life" resource allocation challenges.

In order to achieve this, this study aims to answer the following two research questions:

Number 1: Does the combined application of "soft" operational research and system dynamics result in reasonable representation of a generic resource allocation framework in model form?

Number 2: Does this model yield interesting management insights for NGO management that could help improve their own resource planning and allocation processes or decisions?

In addition, this study aims to provide some analysis and insight on the implications of different management scenarios on select variables within the resource allocation model.

For the purposes of this study, we will focus on developing a model that is applicable for international NGOs, that is NGOs with a global scope and reach, operating in a number of different countries on focussing on a range of developmental and environmental issues. Specifically, ActionAid International will be used as a detailed case study with additional insights and comparisons with Greenpeace International, and to a lesser degree, Amnesty International and Médecins Sans Frontières (MSF) International.

1.3 High level approach

A system dynamics approach was used to develop a model whose behaviour is representative of the challenges faced by international NGOs with regards to resource allocation. Qualitative descriptions of "real world" resource allocation challenges, understood through a series stakeholder engagements with participating INGOs, were further refined using problem structuring methods to gain a deeper understanding of the core components of resource allocation that should be addressed in the model. These were then converted into level and rate equations to establish a generic system dynamics model that simulates "real world" behaviour with a sufficient degree of confidence. Although these were largely based on ActionAid International experiences, critical commonalities were drawn across all participating international NGOs in order to arrive at a more generic model that could potentially have wider relevance.

A set of management scenarios were then developed, drawn from a range of management, policy or external challenges that international NGOs typically encounter during the planning and allocation of resources. These scenarios form the basis for conducting experimental runs on the generic system dynamics model, testing different parameters in an effort to compare quantitative results. These quantitative results were used to compare performance against the original generic model, analysing trends and model behaviour to inform qualitative recommendations and conclusions.

1.4 Dissertation structure

This dissertation is organised as follows:

Firstly, a brief background to this study is provided in Chapter 2. This includes an introduction to Non Government Organisations (NGOs) and the development context in the 21st century (Sections 2.1 and 2.2). ActionAid International and Greenpeace International are introduced as two examples of international NGOs that have adopted decentralised structures, the NGO profile that is of interest in this study (Section 2.4).

Chapter 3 further defines the focus of this study, justifying the choice of resource allocation and the accompanying modelling approach, that of system dynamics (Section 3.3). Chapter 4 contains a literature review, with an emphasis on the application of system dynamics in similar contexts (Sections 4.2 and 4.3) and the potential complementarity of operational research techniques in the modelling process (Section 4.4).

In Chapter 5, the stakeholder engagement process is explained and the resulting management descriptions of resource allocation are summarised based on their feedback (Section 5.2). Problem structuring methods are applied to the management descriptions, using soft systems methods (Section 5.4) and strategic options decision analysis (Section 5.5) to create a basis for model development.

Chapter 6 introduces system dynamics as the overall modelling approach (Section 6.2) and describes the resource allocation model that was developed using Vensim PLE (Sections 6.3) including the model's assumptions. Chapter 7 outlines the validation processes that were applied to the model.

Chapter 8 describes the management scenarios that are simulated and the impact of these different scenarios on the performance of the model. The insights generated as a result of the simulated scenarios are discussed in Chapter 9, as they relate to the initial research questions.

Finally, Chapter 10 concludes this study, highlighting insights, reflections and recommendations for future exploration.

Chapter 2

Background to this Study

2.1 Introduction

This chapter introduces Non Governmental Organisations (NGOs) and describes how these organisations are evolving in response to the increasing complexity of development issues that plague global society. The concept of *decentralisation* is explained in relation to an NGO's organisational structure, using ActionAid International as an example.

This chapter also explores the effect of decentralisation on a NGO's *resource allocation mechanism*, the organisational mechanism of interest in this study. ActionAid International and Greenpeace International are used as examples to compare the different characteristics and challenges of resource allocation in decentralised NGOs.

2.2 The origin of NGOs

The United Nations coined the term, Non Governmental Organisation (NGO) after World War I [Davies, 2016], however one of its earliest manifestations was the anti-slavery movement in the late 18th and early 19th centuries [Davies, 2016]. This movement involved groups of people across the globe fighting for a common cause - opposing the international slave trade. The slave trade was eventually abolished by influencing national legislation and active campaigning during international policy negotiations. Such activities are generally performed by today's NGOs.

In the 19th and 20th centuries, large scale international conflicts such as the World Wars and others, required similar international interventions. Medical aid organisations such as the International Foundation of Red Cross and Red Crescent Societies and Save the Children were established in the aftermath of World War I to attend to those suffering in countries on the "losing end" of the war [Davies, 2016]. Just over two decades later, Oxfam and CARE were founded to provide food relief after World War II. The list has grown exponentially ever since, with NGOs' popularity soaring in the 1970s and 1980s, delivering services to those in need and advocating for the poor [Banks and Hulme, 2012].

Today, depending on one's chosen definition, the number of NGOs range from thousands of established international NGOs to millions of smaller, national NGOs [Lewis, 2009]. Lewis [2009] attributes this wide range to the lack of reliable statistics and the varied interpretation of this three-lettered acronym.

For the purposes of this study, Vakil's definition of an NGO as been adopted. Vakil Vakil [1997] summarises such organisations as *self-governing, private, not-for-profit, organisations that are geared to improving the quality of life for disadvantaged people.*

2.3 The complexity of development

The UN-defined, universally-agreed Millennium Development Goals (MDG) were intended to provide a set of common objectives to guide the international development community in its effort to eradicate extreme poverty and hunger by 2015 [UNDP]. *The Millennium Development Goals Report 2015* celebrated some of the MDG's successes, specifically in relation to income, primary education and healthcare. The report also recognises their limitations, critiquing their development and implementation approaches and their uneven progress.

The Millennium Development Goals Report 2015 also mentions the drastic increase of development aid over their 15 year period. Data indicates that official development assistance from developed countries reached USD135.2 billion in 2014. However, Riddell [2010], in his 2010 article on re-thinking official aid, argues that "size doesn't matter". When one switches the emphasis from individual dollars to the change realised per dollar, the resulting *impact* is not as impressive.

The debate around the MDGs, and their newly formed successors, the Sustainable Development Goals (SDGs) reiterates the growing complexity of development with the world's collective problems showing no signs of submission. Figure 2.1 neatly captures this complexity, depicting the traditional pillars of sustainability, developed by the UN, overlaid with multiple feedback loops, reinforcing the interconnectedness of issues and decisions in these areas.

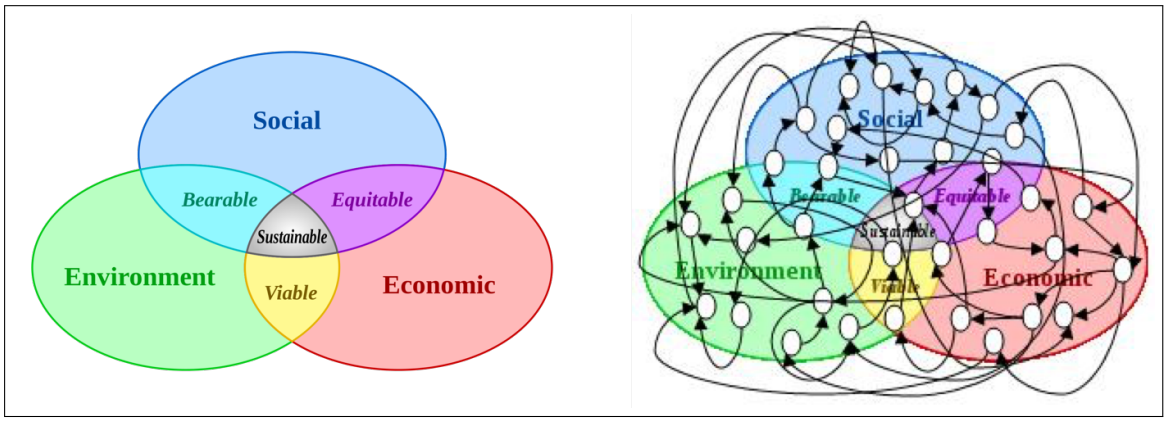

Figure 2.1: Three pillars of sustainability, adapted from the United Nations

Edwards and Sen [2000] summarises the major issues of climate change, migration and the discriminating free market as this century's world wars that will take many lives, mostly of

those living on the edge of society. Edwards and Sen [2000] highlight the economic, social and political forces benefiting the few and the power shift necessary in all three of these areas for *truly* inclusive sustainable development. This is one of the many drivers prompting the NGO sector to change, to better equip itself to respond to these interconnected issues in a more integrated manner.

2.4 The changing role of NGOs

In addition to the complexity of the above development issues, disruptive technology, the role of business in development and the rise of social movements all contribute to the need to re-invent the traditional, rather bulky, international NGOs. Such NGOs are critiqued for their Northern agendas and their inability to be nimble and agile in response to a fast changing society. In 2003, SustainAbility teamed up with the UN Compact and the UN Environment Programme and produced a report called *The 21st Century NGO: In the Market for Change* [Beloe and Elkington, 2003]. This report describes a new model for NGOs which remain critical actors in civil society in the 21st century. In contrast to the earlier NGOs, this report articulates the new model for NGOs as:

- Part of the system, fixing things from the inside
- Solutions-focused
- Growing through networks rather than growing from within
- Gaining supporters from like-minded individuals
- Multi-issue led with a stronger focus on transparency, governance and accountability

Banks and Hulme [2012], in their article, *The role of NGOs and civil society in development and poverty reduction*, also urge NGOs to consider their declining *legitimacy* and encourages closer alignment with their constituencies in communities as opposed to their donors. Banks and Hulme [2012], agreeing with Edwards and Sen [2000], reiterates the political and social exclusion that reinforces the cycle of poverty and that NGOs require a change in *approach*, in addition to the structural changes as described by Beloe and Elkington [2003].

This change in approach requires a move away from service delivery, refocusing on organising and supporting the *empowerment* of communities to effectively *negotiate their own needs and rights* from the state [Banks and Hulme, 2012].

2.4.1 The decentralisation of NGOs

Over the years, many international NGOs have started to adopt the approach of rooted empowerment and mobilisation of communities. Some have also realised that a more *decentralised structure* would increase their ability to build local support and also lessen the influence of donor agendas [Elbers and Schulpen, 2014].

According to Fowler [1992], *decentralisation* in the context of international NGO management, generally refers to an organisational structure where decisions are moved downwards and outwards, visualised in Figure 2.2. This allows for increased authority at a local level, as opposed to head office level. This contributes to an international NGO's legitimacy as decisions (some, generally not all) are taken closer to communities rather than miles away in another country. Although decentralisation can increase legitimacy, Fowler [1992] also describes the added complexity and tension that it creates between the local country office and head office, especially in relation to funding decisions. For example, a local country office, with its indigenous knowledge, may know which project would have the most impact but the head office may feel the decision is subjective due to local pressures [Fowler, 1992].

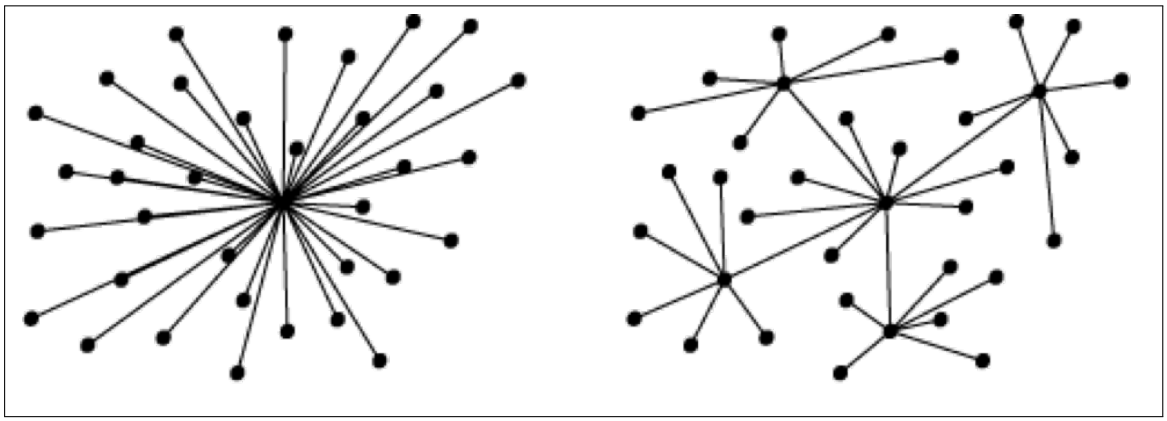

Figure 2.2: A simple illustration of centralisation versus decentralisation

The debate around decentralisation is ongoing with many arguing the advantages and disadvantages of adopting such a structure [Elbers and Schulpen, 2014]. This study refrains from delving further in this debate. Rather, this study acknowledges that such a structure exists, and can take on many forms [Fowler, 1992]. It is the *effect of decentralisation on NGO management processes* that is of particular interest and this is explored through the example of ActionAid International.

ActionAid International: An example of a decentralised international NGO

ActionAid International is an early-adopter of decentralisation and continues to grapple with the complexity that accompanies such a structure. ActionAid inspired this study and an overview of the organisation and its decentralisation journey is described in the following text box.

ActionAid began fighting poverty in the 1970s as a UK-based, child sponsorship charity. The organisation began with 88 individual supporters from the UK sponsoring 88 children's schooling in India and Kenya. During the 1970s, ActionAid expanded into Rwanda, Burundi and The Gambia. The organisation continued to focus on education but was also involved with long term health and sanitation programmes, agriculture and emergency response [ActionAid, a] whilst remaining focused on improving the lives of the children that the organisation sponsored.

In the 1980s and 1990s, ActionAid continued to expand into new countries, moving away from a service delivery approach to focus on tackling the structural causes of poverty [ActionAid, a]. ActionAid began to work with whole communities, organising these communities to challenge injustice and demand their entitlements from their governments. This became known as the **Human Rights Based Approach (HRBA)** which *"centres on active agency: supporting people living in poverty to become conscious of their rights, organise and claim their rights and hold duty bearers to account"* [ActionAid, b].

In the 2000s, ActionAid continued to transform its approach and its organisational structure to fight structural causes of poverty. Even with its progressive HRBA approach, ActionAid was still seen as a traditional UK charity "delivering" aid to the South. It became increasingly evident that this type of an organisational structure would not address the persistent poverty and inequality for those that ActionAid strived to support [Jayawickrama and Ebrahim, 2013]. As such, ActionAid decision makers began the discussion of transformation into a *decentralised federation*. This transformation would entail distributing power to its member countries, being more accountable to the people communities within which they work, expanding and becoming more legitimate in the South [Jayawickrama and Ebrahim, 2013]. This discussion was formalised in 2003 with the founding of ActionAid International [Jayawickrama and Ebrahim, 2013], a federation.

Over the last decade, ActionAid continues to build its democratic and decentralised federation with over 30 members working in 45 countries. A central International Secretariat, practically and symbolically headquartered in Johannesburg, supports the federation and serves the federal governance structures of the International Board and General Assembly. This governance model has made ActionAid unique amongst its peers although not it is not without its challenges. Improvements continue to help clarify decision making principles in the federation, strengthen compliance and support national general assemblies [Jayawickrama and Ebrahim, 2013], without losing sight of the primary purpose of this exercise - developing a more impactful organisation.

The Jayawickrama and Ebrahim [2013] account of ActionAid's decentralisation journey is one of the few detailed case studies and Elbers and Schulpen [2014] mention the need for more empirical research on different NGOs transformations, beyond a theoretical narrative.

2.4.2 Resource allocation in decentralised NGOs

As Fowler [1992] mentions, decentralisation adds tension and complexity in an organisation, especially when it comes to funding decisions. As a result, many decentralised NGOs have had to adopt a more formal mechanism to ensure that funding decisions are transparent, consistent and adhere to the necessary policies that govern a decentralised NGO.

This study continues to use ActionAid as a working example and its resource allocation framework is described below. Greenpeace International's organisational profile is also introduced and its resource allocation mechanism is discussed to provide a comparison for this study.

Please note that information regarding management processes such as resource allocation for specific NGOs such as ActionAid and Greenpeace is limited. The below descriptions are an interpretation based on interviews in 2016 with various managers in the two international NGOs.

Resource allocation in ActionAid:

ActionAid created its first resource allocation framework in 2010 which was implemented in 2012. The purpose of the resource allocation framework was to provide ActionAid with a transparent system for allocating financial resources in the interest of the common good of the federation, aligning to the global mission and strategy. The framework consisted of a set of policies that determined how financial resources were allocated between units within ActionAid International and how the International Secretariat and the federation's international work were funded. This framework was governed by a set principles enabling the federation to maximise its influence and impact, maximise income from supporters and donors and ensure mutual accountability.

In 2016, ActionAid revised the resource allocation framework, building on its previous principles, ensuring it is "fit for purpose" in response to updated fundraising strategies and changing external contexts.

A description of ActionAid's current income: In 2016, ActionAid's total income was EUR229m, a 6% decrease from 2015, mostly due to exchange rate losses as a result of the UK's decision to leave the European Union (Brexit). This is an example of an over-reliance and susceptibility to the European economic climate [ActionAid, 2017]. This continues to be a driver for fundraising investments in new emerging markets in order to diversify income [ActionAid, 2017]. ActionAid's income is primarily restricted with 65% of funds "ear-marked", pre-allocated prior to receipt [ActionAid, 2017].

ActionAid's revised resource allocation framework aims to increase the predictability of income and increase the funds to be pooled for collective allocation, prioritising certain amounts for investments. The frameworks supports widespread collective contribution to reduce over-dependencies in few markets and to facilitate the selection of a small number of global priorities chosen from competing demands for funds..

Resource Allocation challenges:

As mentioned previously, most of ActionAid's funds are generated in Europe which makes ActionAid susceptible to European related financial crises, as was experienced with Brexit

and, prior to that, the 2008 financial crisis [ActionAid, 2017]. This has increased the necessity of any resource allocation mechanism to be robust against external shocks and have the ability to be responsive to changing contexts.

Stakeholder interviews also revealed the challenges experienced in the implementation of resource allocation framework itself as a number of these related processes operate fairly separately. Efforts have been undertaken to synchronise these however balancing this to curb complexity is key to ensuring that the processes remain manageable for smaller country offices.

Finally, ActionAid's income profile indicates that a large portion (65%) of income is restricted. As the resource allocation mechanism is predominantly used to allocate unrestricted funds, this limits the ability of the mechanism to fully achieve its goals.

In contrast to ActionAid, Greenpeace International's income is largely *unrestricted*. Therefore, exploring the organisational set up, resource allocation characteristics and challenges in Greenpeace provides a useful comparison to understand potential similarities and differences between these organisations.

Greenpeace International: A comparison

Greenpeace is a global campaigning organisation that works across 41 countries and is supported by 2.8 million supporters [Greenpeace]. It's stated mission is to be *"an independent campaigning organisation, which uses non-violent, creative confrontation to expose global environmental problems, and to force the solutions which are essential to a green and peaceful future."* [Greenpeace].

Greenpeace is comprised of independent regional and national offices as well as a central office called Greenpeace International, all separate legal entities. The independence of these regional and national offices are critical from a cross-liability perspective ensuring that actions from one office cannot be held against another office in another country.

A description of Greenpeace's current income: According to Greenpeace's worldwide financial statement published in their 2016 annual report, the organisation continues to grow with a total income in 2016 of EUR342m, an increase of 0.6% from 2015. Over the past years Greenpeace has been susceptible to volatile exchange rates, especially that of the Euro, which affects the value of non-Euro-based equity held by other Greenpeace organisations [Greenpeace, 2017].

Resource allocation in Greenpeace:

Of the 26 offices, approximately 20 contribute financially to the funding of the Greenpeace head office. This contribution differs for each office and is based on the net fundraising income of a given office. A proportion of prioritised funds is allocated to a set of priority countries that are agreed upon every three years. These funds, known as block grants, are committed with specific fundraising or campaigning targets in mind. The intention of these block grants is to contribute to the establishment of national and/or regional offices so that each office has adequate funds to make independent decisions and represent itself to the best of its ability within the wider organisation.

Greenpeace is experiencing income growth [Greenpeace, 2017] however some of this growth is taking place in countries where it is difficult to extract funds based on certain legal requirements in countries resulting in the "ear-marking" of global resources. Foreign exchange losses have proven to be a challenge and any shortfall may results in internal projects being out on hold. When de-prioritisation has to take place, it is always the objective to protect the Greenpeace campaigns as much as possible.

In terms of reserves, each national or regional office as well as the centre hold reserves. All the offices in Greenpeace adhere to a common reserves policy. If an office's reserve level is higher than the policy then the surplus is released for collective investment (over and above the regular contribution). Greenpeace has a risk based reserves policy so reserves can be held for a number of specified risk mitigations rather than having x number of months reserves.

Resource allocation challenges:

There are increased legal restrictions on outgoing funds (i.e. funds raised in one country to be spent in another). This limits the ability for Greenpeace to allocate these funds flexibly across the organisation. Some countries have stricter laws, limiting the movement of outgoing funds to the purpose that the funds were initially raised (campaigns and associated overheads). The growth of neo-liberalism also means that countries are increasing the restrictiveness of their funds. Another challenge mentioned above is that of the fluctuations of exchange rates. A variance at risk model is used to assist in planning however challenges are still encountered due to the volatile nature of exchange rates.

2.5 Summary

The nature and complexity of development issues, the fast-changing environment and the changing management structures of international NGOs provides many opportunities for the application of Operational Research. This study focuses on the impact of decentralisation on the resource allocation mechanisms in international NGOs and aims to investigate whether a system dynamics model can reveal insights that could address the resource allocation challenges that are experienced.

The following chapter translates this into a more detailed problem statement for investigation in this study.

Chapter 3

Problem Definition

3.1 Introduction

Initial interest in conducting this study stemmed from first-hand management exposure to ActionAid's existing resource allocation processes, the strategic drivers of financial allocation decisions and the complexity of implementation within a decentralised organisational structure and uncertain external environment. However, it soon became evident that other international NGOs with similar structures and strategic intent deal with similar resource allocation pressures.

In the previous chapter, resource allocation as a management mechanism was described, using two international NGOs as examples. This chapter summarises the common management challenges of such mechanisms, based on "real life" examples shared by different stakeholders.

It is important to reiterate that the purpose of this study is to use these "real life" examples of resource allocation challenges to illustrate the application of a system dynamics modelling process and how it can be used to generate insights for management decision making. This study does not look to solve one particular challenge or optimise a specific system.

Operations research (OR) and system dynamics are introduced as the primary analytical approaches that this study utilises to generate these insights and recommendations.

3.2 Management challenges relating to resource allocation

Desk research, together with a handful of key informant interviews with finance, fundraising and general managers within the international NGO sector, revealed a number of management challenges in relation to resource planning and allocation. These summarised challenges provide an initial flavour of the system that is modelled in this study.

It is important to note that the below are neither an exhaustive list nor applicable to every international NGO, rather a handful of common challenges that are of interest from a system dynamics modelling perspective in this study.

- **Conflicting objectives:** Resource allocation plays an important role in ensuring equitable distribution of financial resources across an NGO and ensuring that every member has the ability to contribute in a meaningful way to the NGO's global agenda.

  Allocation principles, policies and objectives need to balance financial sustainability, the organisation's political identity and programme impact. These objectives often work against each other therefore need to be prioritised and re-prioritised periodically to take into account their wider operating context.

- **Internal process complexity:** Principles and policies that govern global allocation are collectively agreed through various decision making forums within an international NGO. However, translating these into implementable processes which can then be systematically applied across a diversity of country contexts often requires cumbersome processes with lengthy consultations to ensure sufficient transparency. Quantitative allocation rules need to be robust enough to explain shortfalls or insufficient allocation whilst not undermining wider confidence.

- **External restrictions placed on funds:** Generally, some form of restriction is placed on funds received by international NGOs. These restrictions can relate to donor requirements or government restrictions placed on outgoing funds in fundraising countries, specifying to which location and/or activity funds can be allocated. Restrictions often apply to overhead/operational costs such as administration, finance and IT making it difficult to invest in internal organisational improvement initiatives, technology investments etc. It is crucial that allocation mechanisms can therefore take these restrictions, or "ear-marking" of funds, into account when making strategic funding decisions.

- **External uncertainty:** Political and economic fluctuations in both donor and programme countries can have a significant impact on the *amount and type* funds flowing through resource allocation mechanisms. One such manifestation is foreign exchange instability which has a direct effect on the movement of funds from one country to another and should be considered as part of risk management. Economic climate can also have an effect on the "charitable" behaviour of donors (whether individuals, organisations or governments).

3.3 Justification of the approach

The analysis of a management mechanism such as resource allocation lends itself to **operational research (OR)** approaches. It deals with the allocation of limited resources, aims to achieve some optimal allocation as described by a set of strategic objectives (sometimes conflicting) and occupies an interesting management space intersecting both quantitative (financial) and qualitative (strategic) decision making.

Given the "blurriness" and complexity of such mechanisms and the interface with various decision makers, this study uses "soft" OR techniques [Forrester, 1994], such as problem structuring, to better define the resource allocation "problem", creating a common representation based on the various stakeholder perspectives gathered throughout this study.

This structured representation of the resource allocation mechanism is transformed into a **system dynamics model** in order to simulate its behaviour. Different model variations (management scenarios) are used to explore the effect of certain policy manipulations on the "real-life" challenges that the stakeholders discussed. This creates an understanding of the impact of recommendations and solutions on the whole system, taking into account the various conflicting priorities and feedback loops.

A system dynamics approach is considered an appropriate modelling tool in this study for the following reasons:

- A system dynamics model can take into account organisational learning through the incorporation of feedback loops [Sterman, 2000]. This will enable the model to better simulate effects of different policy parameters. This is particularly important in the NGO environment where learning and accountability are important aspects, especially from a programmatic perspective, ensuring that interventions are not doing more harm than good. Regular review and reflection processes take place however the degree to which the learnings from these are incorporated into future strategies and plans is debatable.
- System dynamics literature emphasises the impact of *mental models*, especially when structuring a problem [Forrester, 1994] and [Sterman, 2000]. A mental model provides an intuitive understanding of a system that one's mind cannot comprehend in its entirety [Sterman, 2000]. Sterman goes on to mention the extent to which such mental models can influence the way feedback is incorporated into a system. This is particularly relevant in a decentralised decision making structures, where representatives of constituents are entrusted to make decisions that contribute to the larger global strategy beyond their immediate management remit.

The above serves as initial motivation to investigate the application of a system dynamics approach in modelling a generic resource allocation mechanism to explore how this approach might generate learning and insights for NGO management.

The Literature Review, in the next chapter, introduces the system dynamics approach and explores other system dynamics models and their application to development, management strategy and resource allocation. Soft OR techniques are discussed in terms of the complementarity of application in the system dynamics process, offering tools to support the social/people processes that interact with modelling and computer simulation processes.

Chapter 4

Literature Review

4.1 Introduction

This literature review explores the application of system dynamics theory in similar management or development contexts and discusses the findings and insights that would inform its application to resource allocation. To the author's knowledge, there seems to be limited literature focusing on modelling financial resource allocation in international NGOs. This provides further motivation to undertake this study and, in doing so, contribute to the practical application of system dynamics in international NGO management contexts. Having said this, there *is* a wealth of literature on the application of system dynamics in the wider management, economic, development and political arenas.

In this chapter, system dynamics as an approach is introduced, followed by its application in various contexts. Three specific case studies are discussed, reflecting on the similarities and differences of approaches in the development and/or social context. This chapter also discusses the OR techniques that have been applied to resource allocation and the potential complimentary of these techniques with system dynamics in the overall modelling process.

4.2 System dynamics application in development

4.2.1 An introduction to system dynamics

It is virtually impossible to start a system dynamics discussion without beginning with words from the "founding father" himself, Jay Wright Forrester. Forrester has been instrumental in this field from its inception in the mid-twentieth century [Forrester, 1989] and has shaped this field of study with his thought-provoking insights and punchy challenges.

Forrester neatly recaps the birth and formative years of system dynamics in an article published in the System Dynamics Review in 2007 [Forrester, 1989]. In his paper, Forrester [1989] reminds audiences that system dynamics, similarly to OR, is a field responding to the practical, "real world" challenges that humans grapple with on a daily basis. The application of system dynamics originally concentrated on engineering systems and, during the 1930s and

1940s, was focused on military operational issues, experimenting with radar controls and more sophisticated flight simulations during World War II [Forrester, 1989].

Since then, system dynamics has expanded its applications into management fields, economics and public policy with computer modelling software improving alongside it [Forrester, 1989]. As system dynamics increased its reach and diversified its application, the variables that underpinned these models also diversified. Soon models were dealing with abstract variables to unpack, for example, the effect of management influence and leadership qualities on corporate strategy [Forrester, 1989].

Important publications such as Urban Dynamics [Forrester, 1969] and, later World Dynamics [Forrester, 1971] with its encore Limits to Growth, shone a spotlight on the field. These publications critiqued ineffective, sometimes harmful, public policy and the impact of our "bigger is better" mindset when it comes to consuming resources. These arguments continue today, revived amidst the various climate change debates taking place [Meadows et al., 2004].

Following a fifty year "growth spurt", Forrester believes that the system dynamics field has plateaued in the 21st century. He attributes this to the fact that system dynamics has spread itself widely without the adequate depth in expertise to effect real change as it relates to world's complex problems [Forrester, 1989], also highlighting the pressure of academia prioritising journal articles over public relevance [Forrester, 1989].

In addition to this, the current system dynamics approach of taking a smallish issue, applying system dynamics modelling and showing the results to the relevant decision makers is not an optimal approach that results in large scale change [Forrester, 1989]. Forrester believes that one must change the policies that govern the status quo to achieve fundamental societal change [Forrester, 1989].

Policy change requires public support as well as decision makers as influencers. Forrester reminds us that system dynamics is not simple and to exercise caution when oversimplifying models. Complex problems may require complex solutions and Forrester urges practitioners to focus on high-leverage policies, not to shy away from controversial results and to work towards policy changes that are appropriate for implementation [Forrester, 1989].

4.2.2 System dynamics and development

System dynamics has been applied to countless real world situations in an effort to better understand the nature of complex systems and the drivers of their behaviour. Khalid Saeed led the expansion of system dynamics application into the development arena. He has spent much of his academic and professional career modelling economic and policy development from a systems perspective, covering diverse topics including income distribution, resource allocation and political dynamics [Saeed, 1995].

Saeed's contribution to the system dynamics discipline is widely recognised with his book *Towards Sustainable Development* being awarded the prestigious Jay Wright Forrester award in 1995. In this book Saeed presents a collection of models that analyse developing countries social and economic systems [Saeed, 2016].

John Sterman mentions in the award citation, how the papers within Saeed's book break the boundaries of traditional disciplines. The models in his book include economic, political, social

and resource implications on national policies, reflecting the integrated nature of such systems [Saeed, 1995]. Sterman also commends these models for their ability to capture the dynamics, disequilibriums, non-linearity and other elements of complexity. These elements are more representative of the day to day fluctuations compounded by lingering effects on long-term policy ineffectiveness [Saeed, 1995].

Arguably problems associated with sustainable development and challenges facing developing countries can be seen as more important to solve (or at least better understand), as opposed to modelling business systems set in highly developed countries. To some degree, this study will be investigating the intersection of these management policies and practices, balancing inflows of resources from mostly developed countries with the outflows, via programme interventions, in developing countries.

Models from Saeed's book, as well as others, are further discussed in the next section.

4.3 System dynamics case studies

This section discusses three case studies in order to provide insights into the current application of system dynamics approaches to management strategy, policy design and resource allocation. These case studies consider models both from a development perspective as well as from a corporate perspective.

This discussion reflects on modelling assumptions, techniques and results and how these may influence the development of the resource allocation model for this study.

4.3.1 Application of system dynamics to corporate strategy: an evolution of issues and frameworks - Henry Birdseye Weil

Overview:

In this paper, Weil unpacks five areas that should be considered when applying system dynamics to corporate strategy. Although these models are based on Forrester's industrial dynamics models, Weil incorporates organisational, physiological and social dynamics that heavily influence today's corporate strategies and related decision making processes [Weil, 2007].

The five models discussed in Weil's paper are based on his and other colleagues' professional experience and academic research. The first model describes conflicting management objectives and the impact on organisational targets developed in the 1970s by Roberts. He then goes on to discuss the behaviours of a Research and Development organisation as it balances decisions regarding staffing, resource allocation and strategy. The third model that Weil discusses is that of the long term commoditisation of goods and services driven by market dynamics [Weil, 2007]. Finally, Weil discusses the impact of technology adoption and innovation on strategy as well as other social factors, such as an organisation's brand, that impact strategy [Weil, 2007].

The first and final projects are more pertinent to this study and therefore are discussed in more detail.

Conflicting objectives model:

Weil describes the work of Roberts in the 1970s, whose paper, the *Managerial Applications of System Dynamics* discusses the impact of conflicting performance objectives, most evident in organisations with a prominent management hierarchy. Weil describes Roberts' model of manufacturing, distributing and selling goods, focusing on the flows of goods and cash. Roberts' model, illustrated in Figure 4.1 shows how management decisions based on mid term information can result in a business failing to meet its targets [Weil, 2007].

This model illustrates the pressure to correct variances in projected income, sales and gross margins: management feel pressure to act when variances arise, for example reducing prices to increase sales. However, such remedial actions usually have a delayed impact. In the interim, it could mean that gross margins are impacted and management may shift their attention to correct this instead. The dotted lines in the figure represent the delayed effect of intermediate management decisions to achieve one objective, whilst having an opposing effect on other objectives [Weil, 2007].

Sterman in his book, *Business Dynamics* [Sterman, 2000], discusses the concept of the "mental model" and how humans rely on these models, as simple constructs of more complex systems, when making decisions. These models have limitations such as bias, judgement and imperfect information. The more complex a system gets the more reliant one is on mental models which often ignore, or are not able to take into account, feedback loops and delays in information [Sterman, 2000].

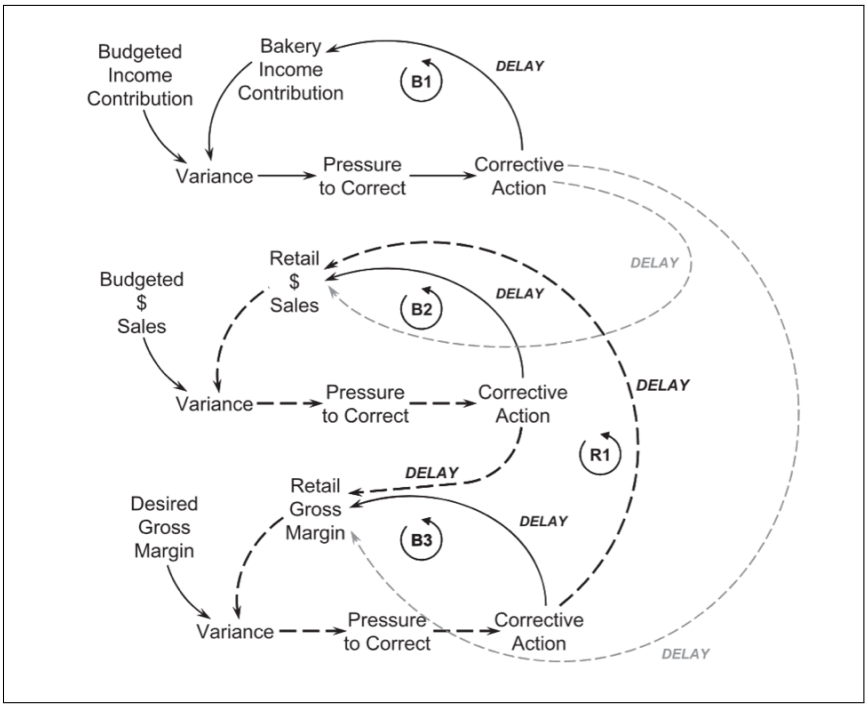

Figure 4.1: Conflicting control loops model [Weil, 2007]

Dynamic Market Relationships:

Weil concludes his paper with a discussion on social factors such as brand, trust and trends

etc. as key influencers in a dynamic market. Customers have abundant choices when it comes to purchasing products and services and Weil acknowledge the influence that a powerful brand has over customer choices [Weil, 2007].

In Figure 4.2, Weil proposes a simple value relationship model which illustrates the interaction of a provider (organisation) and a customer. The provider adds value through personalisation whilst the customer, feeling valued, responds with information that empowers the provider [Weil, 2007]. Weil goes on to say that providers or organisations who have a good level of trust with their customer base are better place to act on behalf of their customer [Weil, 2007].

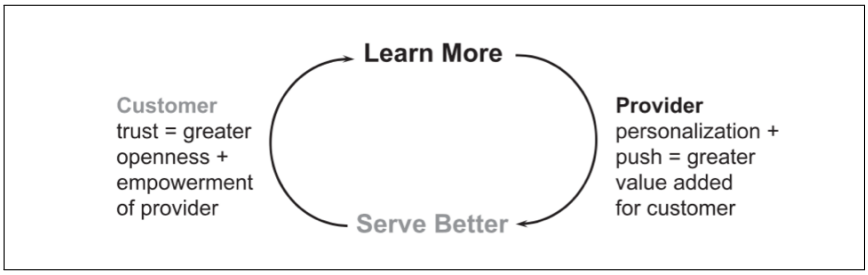

Figure 4.2: Value relationship model [Weil, 2007]

In his current work, Weil is focusing on the modelling and analysis of social factors and customer relationships as they relate to corporate strategy. He uses the example of Apple as an organisation with incredible brand capability which, through its launch of products such as the iPod, coupled with complementary products such as iTunes, has secured large amounts of market share its sector [Weil, 2007].

Weil's concluding remarks in his paper reiterate the fast-changing contexts within which today's organisations operate. Models are therefore required to incorporate new influences such as social impacts, competitive advantage, technology and market evolution [Weil, 2007]. His framing of business dynamics on three interrelated levels; organisation, market and context [Weil, 2007] is of particular relevance in this study as resource allocation in international NGOs also straddles the multiple levels of external contexts, and international and country level application.

Considerations for this study:

The challenge of **conflicting management objectives** is not unique to the corporate sector. Even although Weil highlights conflicting objectives as being exacerbated by hierarchical management structures typical in corporate organisation, the effect of such conflicts cannot be ignored in the decentralised structure of an international NGO.

There are two features that present a challenge when considering performance objectives within a decentralised structure. The first is the dual role of management, referred to within ActionAid as "dual citizenship". Dual citizenship requires a decision maker to consider the organisation actions from an individual country office perspective as well as from a global organisational perspective. This becomes more challenging when developing global strategies, which requires general consensus from country office decision makers who are primarily accountable to their national constituencies.

The challenge of conflicting objectives is probably more pertinent in resource allocation decisions. Although fundraising trends are changing, it is generally the case that funds are raised in high-income, typically Northern countries and are allocated to programme initiatives in lower-income, typically Southern countries. Country office decision makers would understandably prioritise country specific objectives and initiatives over regional or global campaigns and this prioritisation would also be reflected in resource decisions. However, such decisions may not always culminate in the optimal allocation from a global organisational perspective. For this reason a specific decision making group may be designated to consider allocation from a global perspective, and consider what is best for the sustainability and impact of the organisation as a whole. The tension of dual citizenship is an important consideration for this study as are the learnings from Weil's case study, as this effect is incorporated into the resource allocation model.

Although in the non-profit sector, international NGOs are still competing amongst each other for funds and supporters. Accountability, effectiveness and impact are increasingly important for an NGO's "competitive advantage". For an international NGO such as Greenpeace, which generates most of its funds from individual givers, the **brand and value relationship** with its supporters is critical.

Greenpeace has exceptional brand power in the environmental sector with its edgy campaigning techniques and quick adoption of technology in terms of communication, tapping into social networks and digital campaigning as well as having popular, well-known brand ambassadors. Greenpeace individual supporters have little say over the exact allocation of their donations. This differs from ActionAid's child sponsorship fundraising model, where a certain percentage of funds is pre-determined based on the location of the sponsored child. Using Weil's argument, one might infer that this degree of flexibility in funding allocation is afforded to Greenpeace by a fairly satisfied supporter base.

This study will not fully explore the value relationship and brand impact, however supporter engagement and satisfaction are important drivers, linking effective execution of a strategy (as a proxy for achieving impact) to an international NGO's propensity to fundraise. This requires a more in-depth discussion around international NGO brand and funding strategies which is not the focus of this study.

4.3.2 Public policy and rural poverty - a system dynamics analysis of a social change effort in Pakistan - Khalid Saeed

Overview:

This paper was written in the 1980s, a time when developing countries were grappling with structural adjustment policies driven by the International Monetary Fund and the World Bank. These types of structural adjustment and traditional development policies have received heavy critique over the years, some saying such policies further exacerbated cycles of poverty rather than providing any alleviation [Saeed, 2016]. Decades later, global poverty and inequality remain enormous threats and, coupled with environmental repercussions of a consumer society, are *the* topics for debate within development, public policy and economic sectors [Saeed, 2016].

In this paper, Khalid Saeed discusses public policy approaches and unpacks reasons for their ineffectiveness in alleviating rural poverty, utilising the Pakistan case as the basis for his

analysis [Saeed, 2016]. Saeed uses the analysis of this model and the results of this study to argue the importance of incorporating economic factors in policy frameworks to yield better results in relation to redistribution and income equality [Saeed, 2016].

The points that Saeed make in this paper, some three decades ago, are not dissimilar to those found in the recently published book, The Great Divide [Stiglitz, 2015]. In this book, world renowned economist and Nobel prize winner, Joseph E. Stiglitz, echoes the need for a revised policy regime of "equalising" economic and fiscal policies. Policies that would be able to reverse the cumulative, unjust effects of previous policy decisions that have left the world in the state it is today [Stiglitz, 2015].

Income distribution model outline:

Saeed uses an agrarian income distribution model of the developing country, Pakistan, as the basis upon which to apply different policy frameworks to understand their effectiveness in alleviating rural poverty [Saeed, 2016]. Saeed's decision to focus on rural income distribution is reflective of the inability of Pakistan's development policies, focussed mostly on rural productivity and social issues, to affect change on rural household income [Saeed, 2016]. Saeed considers the following core aspects within his model:

- **Land management sectors:** This is a "dualist" economy consisting of a capitalist sector hiring wage farmers and/or leasing land and an entrepreneurial sector of self-employed peasant/subsistence farmers.
- **Land ownership:** The tenure system governs land ownership and protects the rights of land owners. Resources, such as land, are allocated on the basis of the financial ability of each sector (capitalist and self-employed) [Saeed, 2016]. Land owned by each sector changes as the two sectors buy and sell land between themselves. The same applies to the flow of capital between the two sectors.
- **Worker compensation/wage income:** The workforce is split between wage employment and self-employment. Income is both consumed and unconsumed in each sector, with the unconsumed "savings" used to purchase land or capital and, therefore, eventually consumed as well [Saeed, 2016].

The above flows of resources and income streams are governed by the economic decisions made by each sector and are incorporated as feedback loops which drive the behaviour of this income distribution model [Saeed, 2016]. Saeed provides a visual of these positive and negative feedback loops impacting the wage rate in two simplified causal diagrams in Figure 4.3. In this model, the wage rate is primarily driven by the ownership of resources by workers, representing their bargaining power. The effect of the negative (balancing) and positive (reinforcing) feedback loops can be described with the following illustrative examples:

- **Negative feedback loops:** The ownership of resources by workers is influenced positively by the workers' propensity to purchase and save. At the same time, this is negatively impacted by the capitalists' propensity to purchase and save. All other things being equal, a higher wage rate would result in less job offers and a reduction of wage

workers. Higher numbers in the self-employment sector would reduce collective workers' propensity to save as self-employment sector requires more capital. The eroding of workers' ownership of resources and their bargaining power would ultimately drive down their wage rate.

- **Positive feedback loops:** Capitalists have the option to not hire workers and rent out their land (referred to as sharecropping) to cultivators. These incoming rental payments strengthen the financial position of the capitalist sector. As mentioned earlier, the sector with a better financial position has an increased ability to own more land. This is reinforced by the fact that the more land that is owned by the capital sector, means that the rental is driven up due to the higher demand by the cultivators. This increases the financial ability of the capitalist sector and therefore reinforces the decrease in land ownership by the peasant farmers/cultivators [Saeed, 2016].

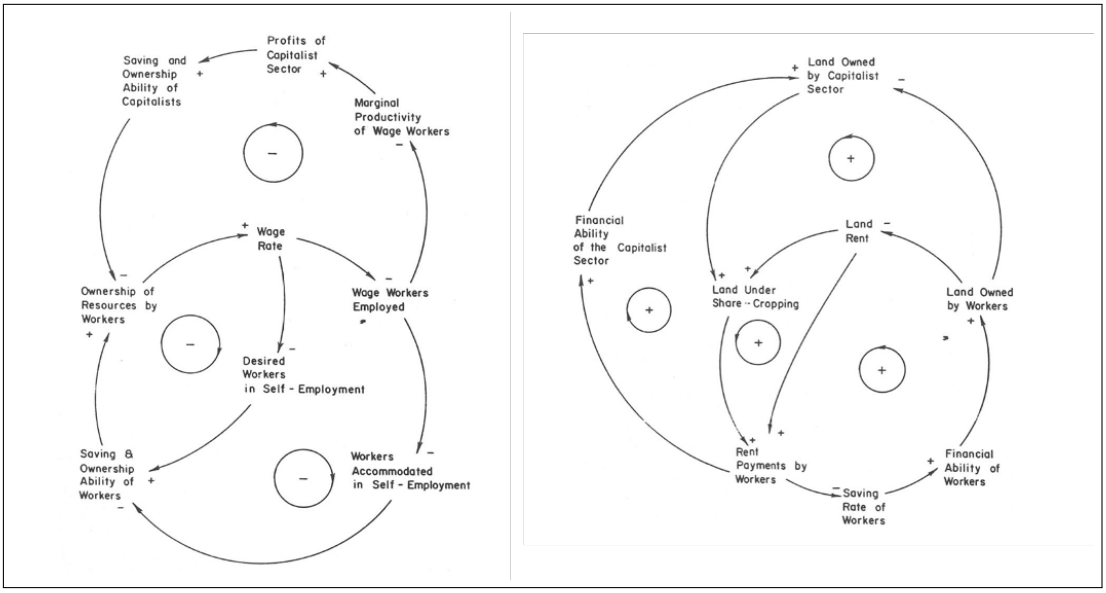

Figure 4.3: Wage rate causal-loop diagrams [Saeed, 2016]

Effects on public policy decisions:

Saeed describes, in detail, the many public policies that were implemented to alleviate rural poverty in Pakistan during the latter half of the 20th century. These policies ranged from rural extension services to provision for agricultural technology, rural credit and promotion of rural collectivism through the formation of cooperatives and land reform [Saeed, 2016]. These policies were all aimed at increasing income of those living in poverty in the rural areas [Saeed, 2016]. Saeed applies these aforementioned public policies to the system dynamics model and simulates their effect on the income distribution system. Unsurprisingly, they fall short of their desired objectives.

For example, Saeed's simulations show that agricultural technology on both a small and large scale increase productivity comparably between capitalist and worker sectors, therefore land management and ownership patterns remain the same and income concentration in the capitalist sector persists [Saeed, 2016]. Similarly, radical land reform policies made some difference

at the start of the simulations, but eventually, land reverted to the capitalist sector which has the greater propensity to intensify productivity with modern farming techniques and fewer workers.

Considerations for this study:

The results of Saeed's simulations and policy analysis bring to light important considerations for this study, specifically as it aims to identify policy recommendations for implementation of an effective resource allocation framework.

Growth and equity represent core objectives of both the public policies in the case of Pakistan as well as objectives for a decentralised international NGO's resource allocation framework. In the case of Saeed's income distribution system, two sectors were identified (capitalist and worker/cultivator) both wanting to increase land ownership whilst maximising their respective consumption [Saeed, 2016]. The system that Saeed modelled, left to its own devices, results in an unequal distribution of income and resources which requires effective policy intervention for sustainable redistribution. In the case of decentralised international NGOs, although member countries have equal voting rights, the financial concentration remains unequal and financial redistribution through a resource allocation framework is required.

Saeed's observations with regards to the **realities policy implementation** is also relevant to this study. Saeed highlights the importance of considering the interactions of different policy interventions and also the unintended results that could counteract the desired objectives. This is especially prevalent in decentralised management structures where implementing a central/standardised policies or mechanisms such as resource allocation will have different implications in different country offices as they operate as independent entities in such a federation.

Saeed's concluding remarks include a set of suggested policies that would better enable growth and equity in the rural sector. Saeed, rather than producing radically different policies, recommends smaller amendments within the bounds of existing interventions, i.e. improving implementation of land reform, rental taxes, migration policies. In principle, this may be better received by decision makers who are invested in and/or responsible for the creation of the previous, less effective, policies.

4.3.3 Implementing performance based programme budgeting: A system dynamics perspective - Grizzle and Pettijohn

Overview:

In this paper, Grizzle and Pettijohn explore performance based programme budgeting (PB^2) and propose a system dynamics model to unpack longer term influences, opportunities and challenges of such a policy implementation using the state of Florida's experience as an illustrative example [Grizzle and Pettijohn, 2002].

According to Grizzle and Pettijohn, *"Performance-based program budgeting requires government spending to be classified by program; programs must have missions and objectives; and input, output and outcome measures must be linked to these missions and to appropriation levels. Programs commit to achieving a specified level of performance for each output and*

outcome in exchange for specified level of funding." [Grizzle and Pettijohn, 2002] Further to this, incentives and penalties may be applied to programmes who achieve or fall short of their performance objectives.

A system dynamics approach is employed to model this reform and to capture the non-linearity and long term feedback loops that are inherent in such systems. It also provides a better understanding of the behaviour of a system and the degree to which different variables influence the overall success of the system over time [Grizzle and Pettijohn, 2002].

Model outline:

Grizzle and Pettijohn built their model on the foundation of a set of critical success factors for policy implementation that have been identified by Edwards in his 1980 paper, *Implementing Public Policy* [Grizzle and Pettijohn, 2002]. Edwards classifies these influencing factors in four categories:

1. Degree of clarity, accuracy and consistency of **communication** regarding policy implementation
2. The availability of **resources** including human, financial and information to support the implementation
3. The **disposition** of implementers, usually a function of organisational culture
4. The **organisational structure** within which the policy implementation is being rolled out

The above four factors were expanded into a theoretical framework based on existing research and case studies to capture the extent of PB^2 implementation in Florida's budget process [Grizzle and Pettijohn, 2002]. The resulting causal-loop diagram, depicted in Figure 4.4, shows the interactions between the different variables influencing the system.

Grizzle and Pettijohn utilise this model to gain insights into the status of Florida's implementation, to understand which variables have higher influence and how these affect the behaviour of the system over time [Grizzle and Pettijohn, 2002].

Considerations for this study:

The model's behaviour is considered through the lens of Edwards' four implementation factors. These features, as they relate to this study, are discussed below.

Grizzle and Pettijohn highlight the fact that the state's overarching accountability model governing budgeting processes is well documented and understood. However, ***how* the budget reform is actually communicated and implemented** is less clear. They go on to articulate the numerous stakeholder groups that need to be involved in agreeing on performance measures and operating guidelines and how the resulting messaging is often confusing and conflicting [Grizzle and Pettijohn, 2002].

International NGO's with decentralised structures are susceptible to these challenges as they have governance and management decision making structures on an international and country

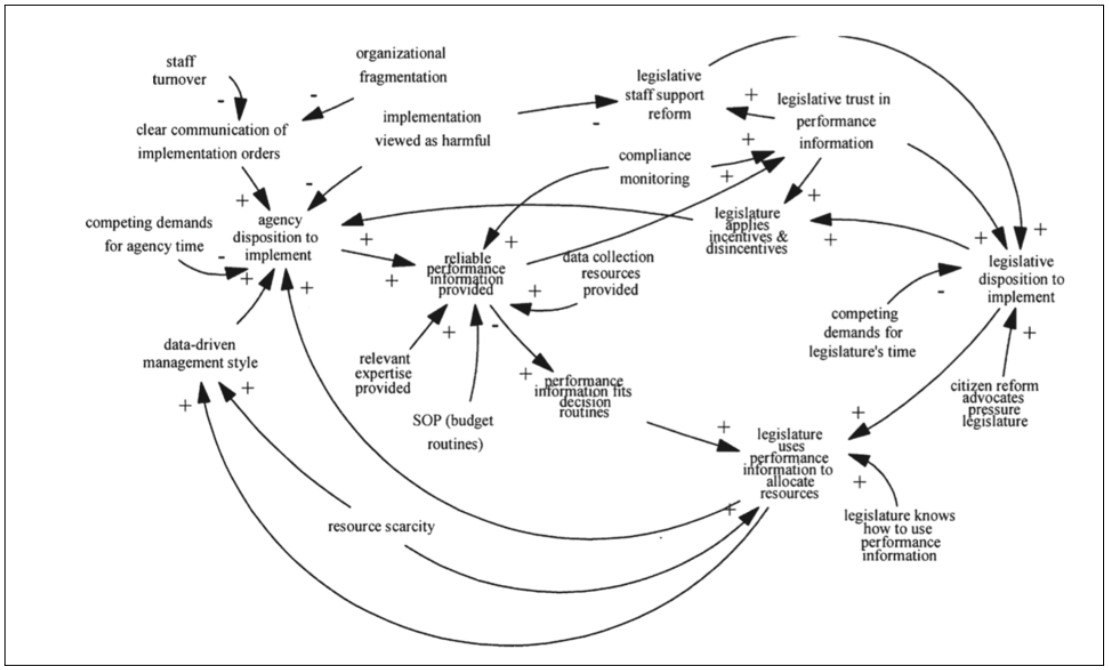

Figure 4.4: Policy implementation causal-loop diagram [Grizzle and Pettijohn, 2002]

level. ActionAid and Greenpeace both have clear allocation policies with accompanying accountability mechanisms, however practical implementation is delegated and so confidence in the decision makers' authority is critical to ensure successful implementation.

Most policy implementations require additional **resourcing and capacity building**. Not only for those responsible for quantitative analysis and decision making but also for those individual projects required to comply with new funding proposal and monitoring processes [Grizzle and Pettijohn, 2002].

International NGOs are diverse organisations with different sizes of country offices and different types of programmes. Overly technical processes tend to put pressure on smaller offices as their decision making structures may not have the capacity to respond to detailed information requests. This needs to be taken into account in terms of time (i.e. progressive compliance), capacity, and the human and financial resources that are required when implementing a new resource allocation mechanism.

Another interesting point to note is the **impact of resource scarcity** on the model. Grizzle and Pettijohn's research reveal that resource scarcity could potentially reinforce the need for budget allocation decisions to be based on robust performance data, especially when budget needs cannot be met [Grizzle and Pettijohn, 2002].

International NGOs have an accountability to donors and to beneficiaries to ensure that funds are allocated to maximise programmatic impact. It is especially important that any reprioritisation or reallocation decisions are be based on agreed performance measures and criteria closely linked to the organisational values.

The above provide important insights into policy implementation within organisations. These aspects will be considered as they relate to the variables chosen for the resource allocation

model in this study and how performance of such a model is evaluated.

4.3.4 Reflection on system dynamics literature

Wise words from Sterman [2000], echoed by a number of system dynamics practitioners, emphasise the importance of building a system dynamics model around a problem/problematic situation rather than attempting to model the system in its entirety. This is important advice as the resource allocation model explored in this study will be concentrating on the behaviours and circumstances that lead to a balanced allocation, meeting the requirements of decision makers whilst being robust against unanticipated externalities.

Although this model will not be all-encompassing and rather focussed on balancing allocation, Saeed's case study on income distribution raises important points about the dangers of ignoring important factors, specifically in policy development, that influence a model's behaviour. One such factor relevant to the resource allocation model will be that of the influence of **earmarked funds** on such an allocation system. Tempting as it may to disregard such funds, as decision makers have little control over their allocation (and these funds generally flow through separate processes), the ability for these funds to skew allocations presents a very real challenge. The incorporation of ear-marked funds into a system dynamics model such as this may provide useful insights in this regard.

The **effect of delays**, whether its in the transfer of information or the transfer of physical funds is a hindrance and common in reality decision makers face with resource allocation. Weil [2007] discusses the limitations of long term strategies based on short to mid term information. It is therefore important to incorporate appropriate delays into the resource allocation model to better understand their effects on the long term performance of the mechanism.

The next section shift the focus to the *process* of developing a system dynamics model. It considers how "soft" OR techniques can be employed to better structure a problem that forms the basis of the simulation model. This is necessary when attempting to consolidate diverse stakeholder opinions into one accepted representation of a situation or problem.

4.4 Operations research, system dynamics and resource allocation

4.4.1 System dynamics and soft OR

Forrester, in his paper, *System Dynamics, Systems Thinking, and Soft OR*, introduces various complementaries between system dynamics and soft[1] OR techniques [Forrester, 1994]. As discussed in the previous section, one of system dynamics most beneficial attributes is its ability to incorporate complexity, non-linearity and feedback loop structures into its models, allowing for a better representation of "real world" systems [Sterman, 2000]. However, actually

[1]Soft approaches are more suited to problems that are not easy to define, where modelling generates insights about the real world and the concern is with the "how" and not the "what". Soft approaches assumes that people's perceptions of the world vary and that their preferences may also differ [Checkland and Scholes, 1990].

developing such a model that adequately represents a real world issue [Forrester, 1994] can be more art than science. In addition, as is evident from the case studies mentioned previously, implementing policy changes that are informed by recommendations from the model can be a serious challenge [Forrester, 1994].

Forrester acknowledges that system dynamics projects can benefit immensely from soft OR techniques in order to support a project's interactions with people/social processes. This would increase the likelihood of decision makers implementing the recommendations based on the results of the system dynamics model.

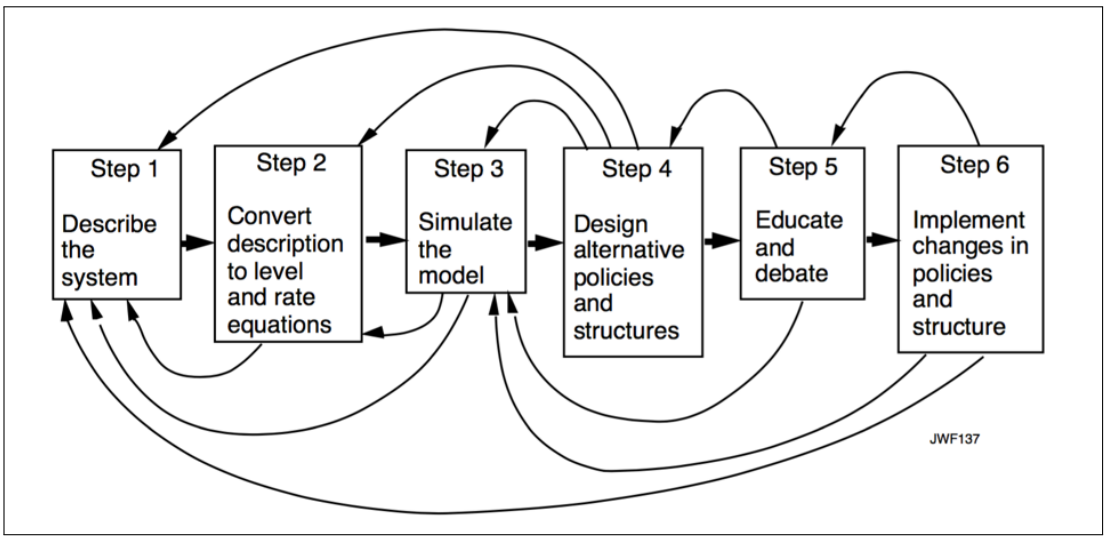

Figure 4.5: System dynamics methodology [Forrester, 1994]

In Figure 4.5, Forrester depicts the system dynamics methodology, beginning with identification of an "undesirable system", transforming it into a model that can be simulated. These simulations can be used to test alternatives and develop recommendations for discussion, with the ultimate goal to implement changes that will result in an improved system [Forrester, 1994]. Soft OR techniques can prove particularly useful in this process. For example, in Step 1, problem structuring methodologies[2] (PSMs) can assist in model conceptualisation whilst decision conferencing or scenario planning can assist with Steps 4, 5 and 6, engaging stakeholders and decision makers in the implementation of system improvements. Two examples of such techniques and their application are briefly discussed below:

- **Strategic Options Development and Analysis (SODA)** is a problem structuring methodology that is often employed to make sense of messy, complex problems [Eden and Ackermann, 2001]. A differentiating factor from its peer methodologies, SODA places equal emphasis on process and content [Eden and Ackermann, 2001]. Cognitive mapping tools are used to depict an individual's perception of a problem (complexity, structure,

[2]According to Shaw, Franco and Westcombe [Shaw et al., 2006] problem structuring methodologies (PSMs) can be described as a set of participatory methods with an aim to engage stakeholders to gain a collective understanding of a problem. Usually such a problem is complex, plagued with uncertainty, with stakeholders bring differing perspective and conflicting objectives [Shaw et al., 2006].

behaviour, relationships etc.) and these are then discussed collectively [Eden and Ackermann, 2001]. These cognitive maps, although personal constructs, could provide useful starting point for conceptualising system dynamics models.

- **Decision conferencing and analysis** is a process through which stakeholders are brought together to address a particular, mutually concerning problem [Phillips and Bana e Costa, 2007]. The process is usually facilitated by an independent specialist who assists in the development of instant models. The group can then interact and reflect upon these models, experiencing in real time how different decisions or changes affect the model [Phillips and Bana e Costa, 2007].

  It is important to note that the models used in decision conferencing processes are not proposed/optimal models, rather models to assist with discussion and debate within the stakeholder group [Phillips and Bana e Costa, 2007]. This type of social process, coupled with the technical system dynamics modelling, can be beneficial as the stakeholders themselves (often decision makers) retain ownership of the problem, engage throughout the process, debating with each other and with the modellers on the representation of issues, results, proposed changes etc. This lays a foundation for a potentially easier implementation process.

Note, the above examples are used for illustrative purposes only and their detailed application is beyond the scope of this study.

4.4.2 Other OR techniques and their application in resource allocation

Resource allocation has been discussed more extensively in the quantitative realm of OR, with the acknowledgement that the qualitative, "soft" OR techniques, as mentioned above, remain critical for any sort of substantial implementation.

Phillips and Bana e Costa succinctly summarise the characteristics typical of "real world" allocation decisions as the following [Phillips and Bana e Costa, 2007]:

1. Benefits described by multiple and often conflicting objectives
2. Decision makers cannot digest all the details and consequences of each project
3. Individual allocations often do not result in the best collective result (i.e. optimal usage of total resource)
4. Resource allocation processes themselves are often cumbersome, political and highly contentious, susceptible to power plays as different units compete for resources
5. Resource allocation, if not managed properly, can result in allocations not aligned to organisational or strategic objectives

The above serves as a useful reality check and another reminder of the importance of supporting group/social processes no matter which technical, quantitative approach is employed for

quantitative modelling. This notion underpins Phillips and Bana e Costa's paper as they investigate the combination of the technical modelling approach of Multi-Criteria Decision Analysis[3] (MCDA) and the social process of decision conferencing. Combining these approaches enables stakeholder to engage in the analysis, explore option or projects whilst prioritising organisational interest over individual interest [Phillips and Bana e Costa, 2007]. Case studies prove the increased value of combining both technical modelling and social processes. However this should not discredit the importance of a high-quality model with which stakeholders can confidently engage [Phillips and Bana e Costa, 2007].

Montibeller and Franco further explore resource allocation modelling from a problem structuring perspective. They acknowledge that allocation challenges not only arise when choosing from an existing list of projects, but challenges also present themselves in *how* such a list is constructed in the first place [Montibeller and Franco, 2009]. Montibeller and Franco produce a framework that looks to structure Multiple Criteria and Area Portfolio Analysis (Multi-CAPA[4]) models.

Their resulting framework considers different methods (and combination of methods) in which to structure criteria, options and areas (areas are made up of groups of options) required to inform the Multi-CAPA models [Montibeller and Franco, 2009]:

- **Structuring options and areas** is explored either *top-down*, identifying areas first and then considering options within each area, or *bottom-up*, brainstorm options and then group into areas.
- **Criteria is structured** either through *alternative-focussed thinking*, defining criteria according to option characteristics or *value-focussed thinking*, criteria based on organisations value and strategic objectives.

Different combinations of the above approaches can be utilised depending on the organisation structure, decision making culture and nature of allocation context.

Stewart, French and Rios present their explorations of integrating MCDA and scenario planning, investigating how the combination of these approaches can add value to decision makers, enabling a better understanding of the uncertainties and risks that impact long term strategic decisions [Stewart et al., 2013]. In their paper published in 2013, Stewart, French and Rios present a framework that considers how management preferences against different elevation/performance criteria can be expressed within or across different sets of scenarios. The idea is that the larger, unwieldy external uncertainties are captured *across* the different scenarios, and uncertainties *within* scenarios can be modelled with probability theory [Stewart et al., 2013]. This is illustrated with an example which explores agriculture policy decisions against various climate-related scenarios [Stewart et al., 2013].

The combination of these two approaches provide an avenue for incorporating probability theory (as the method for modelling uncertainties in quantitative decision analysis) in a manageable process for decision makers. It uses a creative scenario planning approach that stimulates

[3]Phillips and Bana e Costa [2007] describe MCDA as a decision modelling technique that explicitly considers multiple (often conflicting) criteria in decision making situation. Although, MCDA as a concept, is much broader.

[4]Multi-CAPA is an extension of MCDA which can accommodate allocation between single projects and groups of projects organised according to function, geography, objective etc. [Montibeller and Franco, 2009].

"out the box" thinking that is supported by a formal analytical approach (MCDA) that can handle ambiguity and imperfection but can also provide a sense of consistency, rigour and robustness to the process [Stewart et al., 2013].

4.4.3 Reflection on OR literature

It is evident from the above that both quantitative approaches and social approaches play important roles in applied research. The development of a sound model or framework is critical, however its the application of such models and frameworks that bring about departures from the norm, influences decision makers and has the ability to realise change outside of a simulated environment.

Although this study primarily uses a system dynamics approach, it is for the above reasons that it is complimented with soft OR techniques. This study makes use of problem structuring methods to better represent the management challenges that surround resource allocation in a meaningful way. This will then be transformed into a system dynamics model for simulation and further analysis.

Of the above mentioned soft OR techniques, Strategic Options Development and Analysis (SODA) was chosen as the primary PSM tool to capture resource allocation using causal mapping representation. In addition, elements of Soft Systems Methods (SSM) were also employed to enrich the process and to gain potentially new or different perspectives from stakeholders.

The study limits its application to these two soft OR methods whilst acknowledges these as supplementary to the overarching modelling process.

Stakeholder engagement is a crucial aspect to this study and a determining factor for whether this research will have an opportunity for application. Although the stakeholders who were approached were forthcoming with their contributions, especially in describing the current resource allocation mechanisms in place today, engagement was sporadic and tailed off towards the end of this study. Stakeholders were able to provide their professional opinions with regards to the outcomes of the study which led to some surmising about changes that could be feasibly implemented.

The absence of substantial discussions and opportunities for focus groups limited the ability to employ MCDA or scenario planning to further prioritise and evaluate outcomes and recommendations. This could be explored in future studies.

4.5 Concluding remarks

The literature discusses many applications of system dynamics, OR and other analytical techniques that can aid decision makers in management, policy development or simply provide deeper understanding of how and why current systems behave the way they do.

The international NGO environment, as discussed in Chapter 2, is at a tipping point and provides an exciting new opportunity to embrace such modelling techniques in order to improve

their management systems. The applied nature of this discipline means that the interpretation of any model and its results, coupled with deep understanding of the management situation that can be well communicated with stakeholders, is critical in bringing this theory into practice, in other words "easier *modelled* than implemented..."

With limited influence over any specific management decision makers, this study provides an opportunity to expose management and decision makers with a glimpse into the power of such analytical techniques to aid decision making and potentially engage further or utilise similar approaches in future processes.

The modelling process that follows will focus on resource allocation at a *"global"* level, in other words looking at the overall organisation as a group of entities rather than at any specific country office. As most of these international NGOs consist of a diverse set of country offices with varying sizes, it will be difficult to model these country offices individually. The modelling process will therefore include a classification of the various entities in order to create a manageable model whilst still reflective of the macro dynamics at a "global" level. Should any policy changes, or changes to resource allocation mechanisms be considered for implementation further system dynamics modelling should be conducted at a more detailed level to understand implications for specific country offices and/or other entities.

Chapter 5

Stakeholder Feedback and Problem Structuring

5.1 Introduction

This chapter focuses on the application of problem structuring methods to the resource allocation descriptions and challenges that were gathered during the stakeholder engagement process.

The resource allocation context is recapped in the call out box on the following page, setting the scene for the summary of themes and challenges described by the various stakeholders through a series of interviews[1]. It is important to reiterate that the purpose of these stakeholder interviews was to gain insight into the common resource allocation challenges that may be of interest from a system dynamics modelling perspective.

An overview of problem structuring methods is provided, describing the motivation and applicability of such methods when structuring problems for formal modelling. Two problem structuring methods are introduced and applied, namely, Soft Systems Methods (SSM) and Strategic Options Decisions Analysis (SODA). These methods are used to structure the stakeholder feedback, detailing the core components, processes, structures and relationships that are most pertinent for the model development.

The outputs of SSM (a rich picture, root definitions and CATWOE analysis) and SODA (a cognitive map) are then analysed and key considerations discussed through the lens of the system dynamics modelling process that will follow in the next chapter.

[1]Detailed transcripts or voice recordings have not been included in this document. A summary of key themes and challenges upon which the generic resource allocation model is built is considered sufficient for the purposes of this study.

Recapping the resource allocation context: As was discussed in the Introduction and Background chapters of this study, the development and environmental sectors are evolving. Programmatic approaches for tackling sustainable development issues to build equal and just societies have changed. As such, international NGOs, as major players in this sector, are also adapting their structures and processes to the changing environment in order to increase impact. One such organisational change is the move towards a more decentralised structure that promotes collective decision making. Such structures are *federal* in nature.

An organisation with a federal structure is often membership based, i.e. constituted of a number of independent national and/or regional offices. These national and/or regional offices are governed by national governance structures, responsible for the individual office as well as playing a representative role in the federation. This two-part (national and federal) role is often referred to as "dual citizenship".

Although some international NGOs have moved towards a federal structure, such structures are considered more cumbersome than the old "command and control" type structures. Specifically, the processes of allocating resources between different offices needed to change in order to reflect federal values. For example, what was previously a small group of decision makers allocating resources has now changed into a more representative and collective process resulting in the requirement of a more formal framework to govern resource allocation decisions.

Many international NGOs have developed such frameworks over the last few years, however these frameworks have a tendency to be complicated, requiring consistent revision in response to extremely volatile economic and political climates. And although collective decision making brings a quality of diverse perspectives, it also often brings conflicting views and objectives that add complexity.

5.2 Summary of stakeholder feedback

A series of interviews was held with individuals from Greenpeace International and ActionAid International and other professionals within the sector to gain an understanding of existing resource allocation mechanisms and the related management challenges. Perspectives[2] were drawn from international finance and fundraising, international general management, as well as challenges from fundraising offices and programming offices.

Interviewees were selected based on individual interactions whilst at ActionAid International. Those who were directly involved in the resource allocation revision process were invited to participate in this study, ensuring adequate representation of the different "world views" that are outlined in Section 5.4.2. Supporting evidence was gathered through secondary surveys that were conducted, primarily to gather internal stakeholder feedback on ActionAids revised

[2]These were individual perspectives and **do not** represent a formal, organisational position.

resource allocation framework as well as first hand observations in various management meetings where related discussions and decision took place. Based on referrals with the first round of interviewees within ActionAid International, additional stakeholders from peer organisations such as Greenpeace International, Amnesty International and MSF were identified and engaged to provide external perspectives. Interviews were conducted either face-to-face or via Skype between year 2015 and 2016. It is important to emphasis that interviews were based on existing relationships and individual interest in this study as opposed to a random sampling method.

The stakeholder interviews that were conducted are summarised in Table 5.1.

Number	**Organisation**	**Role Title**	**Interview Theme**	**Interview Duration**
1.	ActionAid International	Chief Executive	Strategic and political role of resource allocation policies in a decentralised federation	45 minutes
2.	ActionAid International	Federation Development Director	Programme planning implications at national level	60 minutes
3.	ActionAid International	Fundraising Specialist	Impact of pooling parameters on individual fundraising offices	45 minutes
4.	ActionAid International	Finance Specialist	Financial sustainability aspects of resource allocation	45 minutes
5.	ActionAid International	Regional Coordinator	Stakeholder consultation in resource allocation revisions	45 minutes
6.	ActionAid International	Country Director	Role of resource allocation in distributing power	60 minutes
7.	Independent	Resource Allocation Consultant for ActionAid International	Evolution of resource allocation frameworks in ActionAid	60 minutes
8.	Independent	Organisational Development Consultant for INGOs	Comparison of governance structures of INGOs with respect to resource allocation	60 minutes
9.	Greenpeace International	Finance Director	Detailed characteristics of resource allocation in Greenpeace	60 minutes
10.	Greenpeace International	Operations Director	Greenpeace organisational structure and its implications on resource allocation	60 minutes
11.	Amnesty International	Organisational Specialist	Brief overview of resource allocation in Amnesty	45 minutes
12.	Médecins Sans Frontières (MSF) International	Finance Specialist	Brief overview of of resource allocation in MSF	45 minutes

Table 5.1: Summary of stakeholder interviews

A number of resource allocation challenges were discussed during the stakeholder interviews. The **resource allocation challenges** that are most relevant to this study are summarised below:

1. Resource allocation processes do not adequately deal with resources that are restricted at source, creating a potential imbalance. For example, if an individual bequeaths GBP1 million to a project in country x, this donation generally circumvents the allocation process going directly to country x. Should this donation perhaps be taken into account and the collective allocation amount adjusted?

2. There tends to be a disproportionate level of influence over funds allocation, with fundraising countries having more of say than programme countries. Should fundraising countries' make available surplus reserves for collective allocation at a federation level?

3. Resource allocation processes are fairly static, they tend to be slow in reacting to external uncertainty and as such do not enable predictability and compliance from countries. For example, a market crash in country x may result in the country not being able to contribute any funds for pooling. Should there be allowances in the pooling mechanism for such cases? What are the risks to the overall federation if there is a shortfall?

These challenges exist in an already complex organisational structure and therefore makes for an interesting study through the lens of system dynamics. However, in order to get to a point where a model can be built, the above management descriptions need to be presented in a more structured format.

Problem structuring methods are therefore employed to firstly translate the above management descriptions of resource allocation challenges, into a more structured format, which will ultimately form the basis for the actual system dynamics model.

5.3 Introduction to problem structuring

As discussed in the Literature Review chapter, soft OR techniques can complement the system dynamics methodology, supporting stakeholders to straddle between the "real world situation" and its interpretation into the "systems thinking world" [Forrester, 1994]. Initially, soft OR (specifically problem structuring methods) can help create consensus amongst stakeholders in structuring a "real world" problem/problematic system that can be used to build the system dynamics model. Towards the end of the modelling process, once the system dynamics model has developed with its recommendations, soft OR techniques can be re-employed to assist stakeholders in deciding which changes should be prioritised for implementation [Forrester, 1994].

In this section, two problem structuring methods (PSMs) are introduced and applied to resource allocation, the "problematic situation" that is the focus of this study. The following two PSMs are applied in this study:

1. **Soft Systems Methods:** This is Peter Checkland's approach of expressing a problematic situation through its core systems in a standard way . This approach is particularly complementary as it captures multiple stakeholder perspectives and presents them in a consistent framework [Checkland and Poulter, 2006].

2. **Strategic Options Decision Analysis:** This is Eden and Ackerman's approach of structuring a problem through stakeholder involvement, drawing information from stakeholders using individual interviews and devising cognitive maps that capture the ideas [Eden and Ackermann, 1998].

The following sections describe how these methods have been applied to the resource allocation mechanism and related challenges as described by the stakeholders. Key considerations are summarised to inform the model development.

5.4 The application of Soft Systems Methods

In essence, Soft Systems Methods (SSM) takes a complex human situation/problem and expresses its core constituent systems in a standard way that is representative of the stakeholders' description [Checkland and Poulter, 2006]. It captures the key elements of a problem, whilst taking into account a variety of stakeholder perspectives [Checkland and Poulter, 2006]. Although SSM was developed as a modelling tool in systems engineering, the models are not supposed to represent the "real world". Rather, by using systems rules and principles, it allows stakeholders to structure their thinking about a real world situation [Checkland and Poulter, 2006].

The SSM process is summarised in the following four steps :

1. **Learn** about the problematic situation, including the social and political aspects that may influence the situation
2. **Create** relevant models of purposeful activity that are built based on a particular aspect or view of the situation
3. **Discuss** the situation using the models to identify feasible actions that result in a desirable change
4. **Take action** to improve the situation [Checkland and Poulter, 2006]

Checkland and Poulter [2006] reminds us that the above steps are not necessarily sequential, some activities may take place simultaneously and with various iterations .

This study uses a combination of the following three SSM techniques, namely:

1. Rich pictures
2. Root definitions
3. CATWOE analysis

These techniques are used to define the resource allocation problem in a way that is representative of stakeholder feedback whilst sufficiently structured for easy translation, in this context, into a system dynamics model.

5.4.1 Rich picture analysis

Given the current resource allocation challenges within international NGOs, SSM's **Rich Picture** technique is used to visually represent a resource allocation mechanism in its current context. This is just one interpretation and by no means all-encompassing.

Rich Pictures:

Checkland and Poulter [2006] highlight the importance of understanding the many interacting relationships and prominent features in complex, problematic situations. Such relationships are often better understood through visual representation rather than through words [Checkland and Poulter, 2006]. It is now common practice in SSM to use pictures to capture the different stakeholder perspectives of a certain situation. Through a process of inquiry, the picture is further developed, adding the "richness" of the different entities, structures, players, social and political influences etc. that may contribute to a situation being problematic. Checkland and Poulter [2006] note that such drawings can never fully capture a real situation (nor should they). However, this technique has proven to be a very useful tool to express the core components of a situation in a way with which stakeholders can easily engage, drawing consensus or identifying conflicting views on different aspects of the situation.

Checkland and Poulter [2006] provide some guidance on the key elements that should be considered when developing a rich picture. These elements are articulated below and applied to resource allocation in the context of this study:

- **Structures** - The key organisational structures involved in resource allocation are the *head office* which coordinates the resource allocation process, the *fundraising offices* that determine the amount of resources available and the *programme offices* that receive the funds to meet their requirements.
- **Processes** - The processes involved are those in relation to *funds pooling* and *funds allocation*.
- **Climate** - Political and economic climates affect the amount of funds available for pooling. Higher economic growth provides opportunities to increase funds whilst lower growth may result in decline of overall income (increasing competition for funds). Various political positions may influence where and how resources should be allocated.
- **People** - The external stakeholders in resource allocation include governments, donors and supporters and programme beneficiaries. Internal stakeholders include governance and management staff at the federation (international) and national levels.
- **Issues expressed by people** - Some of the key issues that have been expressed by stakeholders include the complexity of the process, the sluggishness to respond to external uncertainty, the ability of earmarked funds to skew allocations and the different bodies of decision makers involved in the process.
- **Conflicts** - Different stakeholders have different priorities when it comes to the pooling and allocation of funds."Dual citizenship" is an example of one such conflict, as management need to consider both federation/international objectives as well as country objectives when making decisions.

The above elements are incorporated into into a rich picture in Figure 5.1, a simple illustration aimed to synthesise the stakeholder discussion.

The rich picture in Figure 5.1 depicts resource allocation within the context of a collective, representative decision making (i.e. decentralised structure). This picture shows the funds flowing through a centrally coordinated mechanism, overseen by a representative decision making body which incorporates requirements from donors as well as community needs, through a jointly agreed strategy. This strategy guides how funds are allocated. The picture also shows the impact of externalities that can affect both programme and funding requirements such as economic or political uncertainty. The orange arrow depict the earmarked funds that flow outside of the allocation process which can potentially create an imbalance.

Although a rich picture has the advantage of capturing the interplay of different relationships, processes and structures on a single page, additional SSM tools are required to explore the stakeholders different perspectives and requirements of resource allocation. These perspectives form the basis of three "worldviews" which are analysed in the next section, using root definitions and CATWOE analysis.

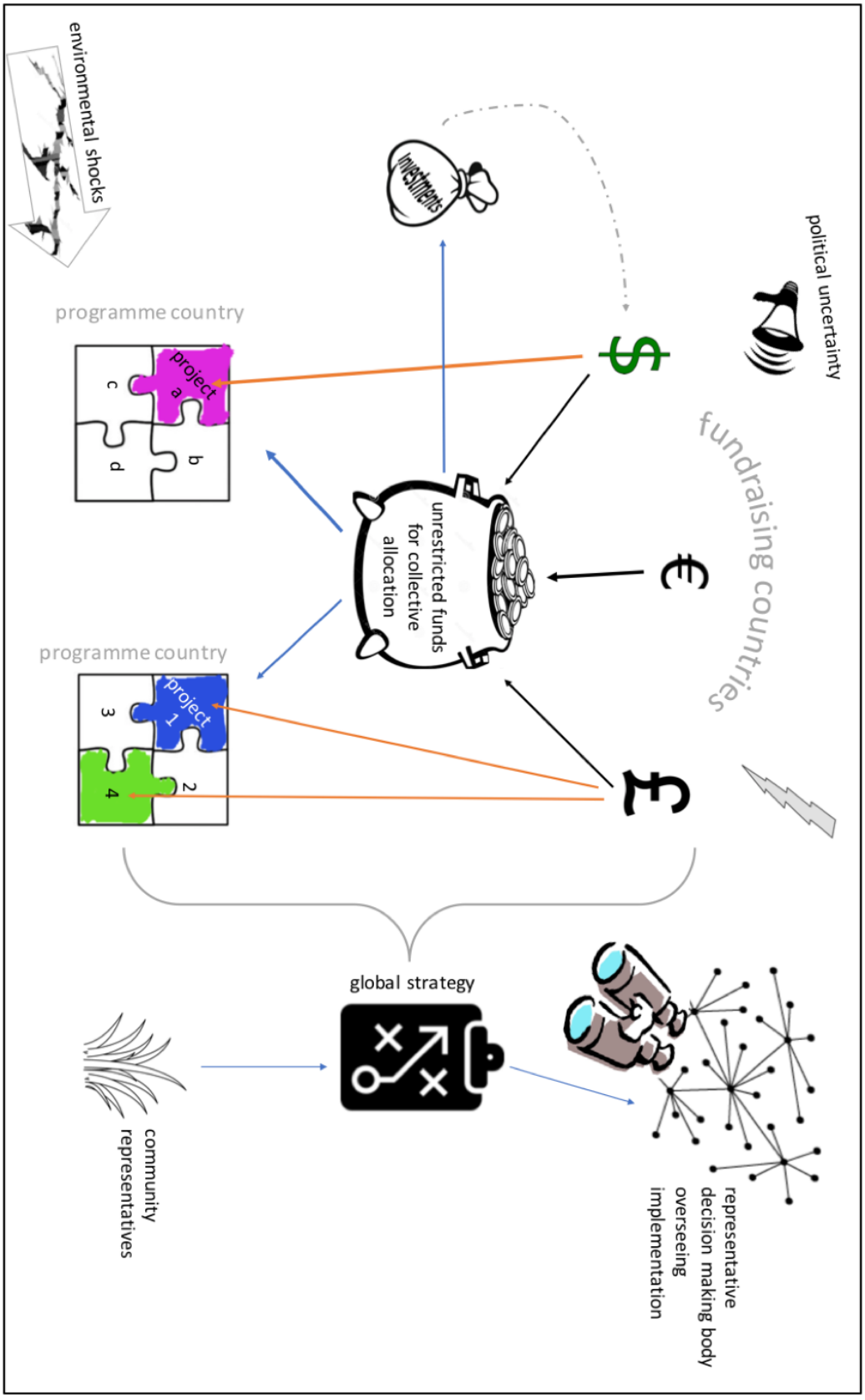

Figure 5.1: Rich Picture: Resource allocation in a decentralised international NGO

5.4.2 Root definitions and CATWOE analysis

Based on stakeholder engagement, three worldviews are considered for further exploration through Checkland's CATWOE analysis. These worldviews are also represented as root definitions, statements about the system activities, that will inform the model building process [Checkland and Poulter, 2006].

A **root definition** is a statement that provides a sense of the overall concept being modelled and is often written in the following form, *"A system to do **x** by **y** in order to achieve **z**"*.

CATWOE analysis breaks down the key elements of the model, grouping them into different categories. These elements include variables affected by the system, those responsible for decisions, why the system exists, what it wants to achieve and the boundaries within which it operates [Checkland and Poulter, 2006]. Checkland and Poulter [2006] offer CATWOE as a mnemonic (**C**lient, **A**ctor, **T**ransformation, **W**orld view, **O**wner, **E**xternal) to categorise these elements. This is depicted in tabular form in Table 5.2.

Clients	The victims or beneficiaries of a system
Actors	Those who would operate the system
Transformation	The core processes that drive the system behaviour
Worldview	The worldview that makes this system meaningful in this context
Owners	Those who could stop the system
External	Elements or constraints outside the system which are a given

Table 5.2: The CATWOE mnemonic [Checkland and Poulter, 2006]

Outlined below are the root definitions and CATWOE analyses for three worldviews:

1. Federation
2. Programme
3. Fundraising

These worldviews are chosen as they represent the different, sometimes conflicting, priorities and requirements of a resource allocation mechanism within a decentralised international NGO. For example, fundraising offices would seek a mechanism that would enable income growth. In addition, fundraising offices would need to ensure that funds raised from respective donors are allocated within the boundaries of the donor agreements. Programme offices, on the other hand, would want to ensure that funds can be allocated to programmes that create the most impact within their country, generally in line with their national development plans. From a global, federation perspective, it is important that an allocation mechanism enables financial sustainability, enabling income growth, whilst also ensuring that programmatic goals are met both at a national and international level.

It is important to note that each of these worldviews can be interpreted in many different ways. What follows is one possible interpretation for each, based on the stakeholder feedback, with supporting root definitions and CATWOE analyses.

1. Federation worldview: Resource allocation should be a system that makes a federation more than the sum of its parts, enabling transformational and systemic change.

The emphasis of the federation worldview is that sustainable transformational change can only be achieved through a collective programme strategy, at an international level as well as at regional and country levels. This is translated into the following root definition and CATWOE representation in Table 5.3.

Federation root definition:A system to pool and allocate federation resources by a collective representative decision making body to maximise global programme impact.

Clients	All members and offices of the federation
Actors	Federation leadership (international and country leadership)
Transformation	A centralised allocation function, transformed into a decentralised, collective resource allocation to align with organisational values
Worldview	Collective federation impact to achieve sustainable change
Owners	Representative governance body
External	Volatile economic climate, limited growth, constricting development aid frameworks

Table 5.3: Federation CATWOE elements

2. Programme worldview: Resource allocation should ensure that programmes can meet their objectives and respond to their beneficiaries' needs.

The emphasis here is to ensure the programmes receive reliable and predictable income to implement projects that meet the needs of their beneficiaries. This is translated into the following root definition and CATWOE representation in Table 5.4.

Programme root definition: A system that allows for programmes to plan with predictable income and which is governed by a transparent decision making process.

Clients	Beneficiaries and communities
Actors	Country and Programme management
Transformation	Funds generated transformed into predictable income to allocate to programmes to me
Worldview	Programme objectives led by community and beneficiary needs
Owners	Representative governance body
External	Political climate hindering programme, humanitarian emergencies threatening beneficiaries

Table 5.4: Programme CATWOE elements

3. Fundraising worldview: Resource allocation should be used to allow more funds to be raised to grow the organisation and increase impact.

The emphasis here is to establish a resource allocation mechanism so that funds requested for

pooling from fundraising offices are realistic and that targets are flexible and can be adjusted. This is translated into the following root definition and CATWOE representation in Table 5.5.

Fundraising root definition: A system to realistically pool funds, that can take into account fluctuations in fundraising environments in order to better realistically plan and meeting fundraising targets.

Clients	Donors
Actors	Country and Fundraising management
Transformation	Realistic funds pooling mechanism that can transform fluctuating income into smoothed budget flows
Worldview	Fundraising strategies to support a financially sustainable federation
Owners	Representative governance body
External	Volatile economic climate, competition for funds, increasing donor requirements

Table 5.5: Fundraising CATWOE elements

5.4.3 Considerations for model development

SSMs ensure that the stakeholders' descriptions of "real life" resource allocation examples are adequately represented for the modelling process.

The three worldviews that were used to form the root definitions and CATWOE analyses (federation, programme and fundraising) have different degrees of power and influence over resource allocation decisions. These various levels of influence need to be addressed through the modelling process and the subsequent simulations and experimental runs, in order to investigate the change in (or not) behaviour of the allocation framework and its effect on the performance criteria.

The effect of external uncertainty has been a prominent feature in discussions throughout the stakeholder engagements. It is therefore necessary for resource allocation mechanisms to be robust against volatile environments that can affect fundraising, programme implementation and organisational sustainability. It is important that the allocation mechanism has the ability to promote a more agile organisation, in other words, making it easier for funds to be reallocated in order for the organisation to have the resources to better respond to changing circumstances.

The following section continues with problem structuring methods. The application of SODA, the second problem structuring method, is described in the next section and yields different lessons and insights.

5.5 The application of Strategic Options Decision Analysis

Strategic Options Decision Analysis (SODA) is used to design problem solving interventions by mapping stakeholder views [Eden and Ackermann, 1998]. The key philosophy of SODA is one of structuring a problem through stakeholder involvement. In other words, SODA

draws out information from stakeholder groups using individual interviews and the ideas are captured on cognitive maps [Eden and Ackermann, 1998]. Cognitive maps provide an avenue to capture a stakeholder's view on a specific problematic situation and to structure this view unpacking goals, objectives, issues, conflicting relationships, feedback loops and so on [Eden and Ackermann, 1998]. Once individual cognitive maps are developed based on individual conversations, these maps can then be merged to produce a strategic map which can then form the basis for further discussion and analysis.

Cognitive maps, in the stricter sense, map out a series of choices, i.e. *do I do **this** OR do I do **that***. Each, choice, referred to as a *concept* in the map is written with three dots (...) to indicate its bi-polarity. For example, the choice between centralised and decentralised decision making, as a concept in a cognitive map, would be written as *centralised decision making... decentralised decision making*, the three dots indicating the alternative choice as decentralisation. These bi-polar concepts are then linked together with arrows that indicate a relationship which can either be positive or negative. By default, an arrow indicators a positive or reinforcing relationship, i.e. the behaviour of x will result in a reinforcing behaviour in y. To depict a negative relationship, a negative (-) sign appears next to an arrow. This means that the behaviour of x will result in a opposing/balancing behaviour in y [Ackermann et al., 1990]. This relationship is illustrated in the simple example in Figure 5.2.

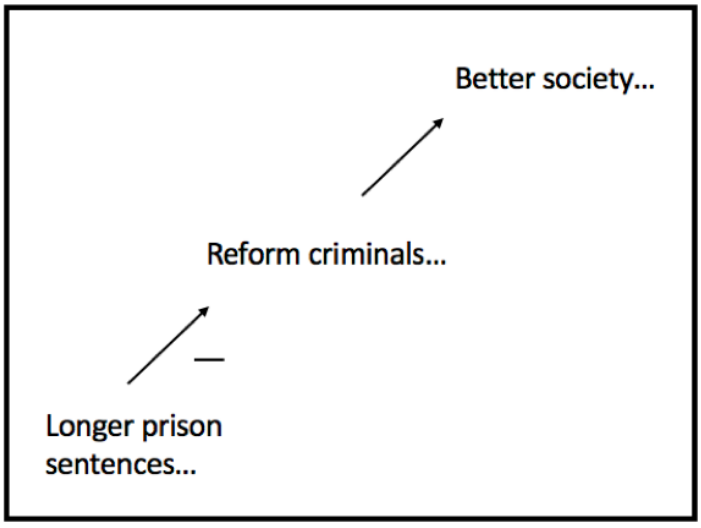

Figure 5.2: Example of conecpts in a cognitive map

5.5.1 Cognitive mapping of resource allocation

The resource allocation problem is expressed as a cognitive map to assist in the development of the subsequent system dynamics model. The cognitive map that has been produced is based on stakeholder interviews and aims to explore the **core purpose of resource allocation** as well as **management challenges** that impact some of the current resource allocation frameworks in practice.

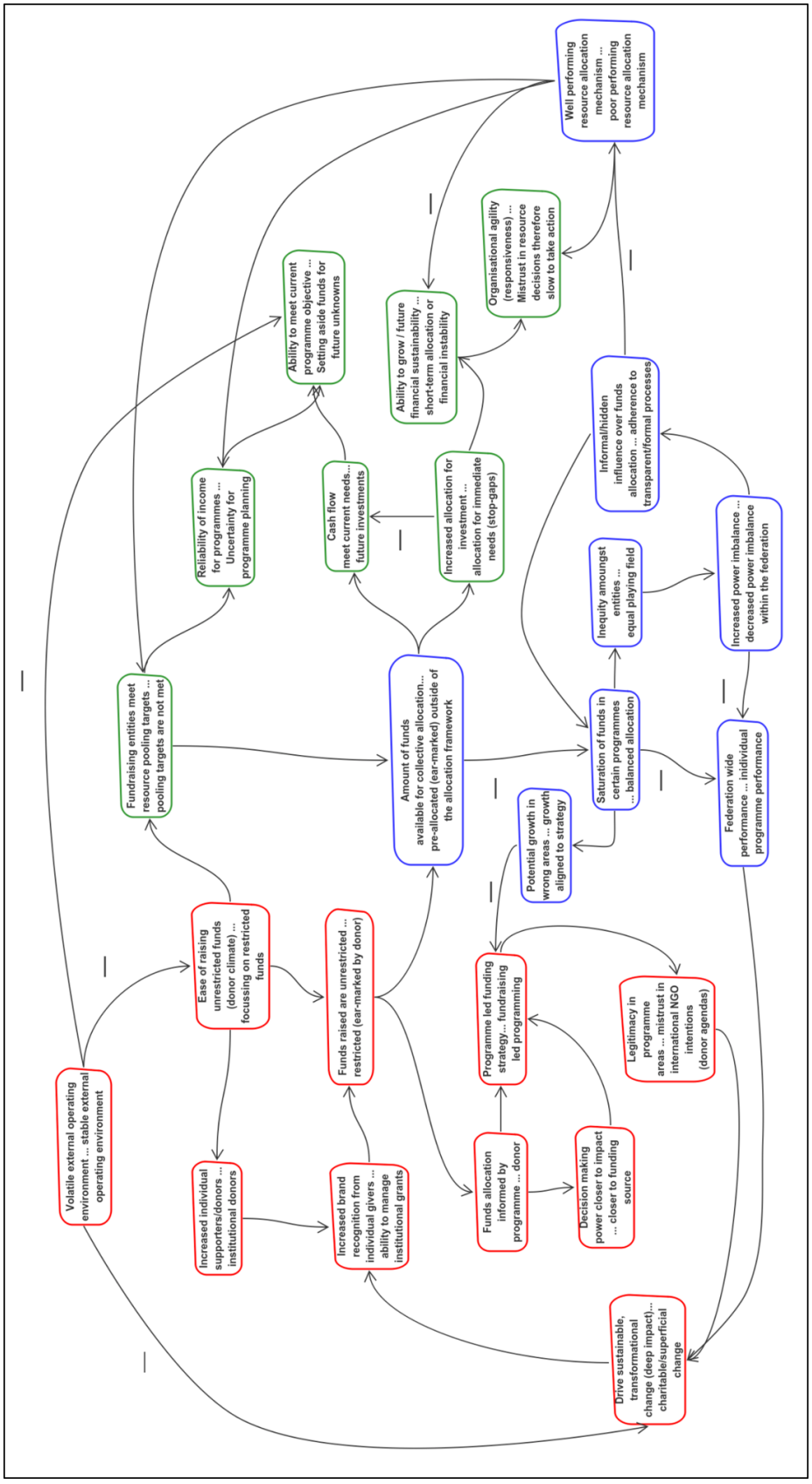

Figure 5.3: Cognitive map of resource allocation in INGOs

Overview of resource allocation cognitive map:

The concepts (sometimes referred to as nodes) in the cognitive map in Figure 5.3 have been colour coded to represent three groups. The concepts in **red** show the *intention* of the resource allocation mechanism and how it supports the international NGO's values of collective decision making and creating legitimacy within the countries and communities within which the programmes are delivered. The concepts in **blue** illustrate how an unbalanced allocation can affect power dynamics and have a negative effect on the international NGO's performance and implementation of the resource allocation itself. The concepts in **green** look at the balance between future allocation (through investments) and current expenditure and the impact it has on cash flow and reliability of income for programmes as well as the longer term impact on the organisation's ability to be responsive to external uncertainties.

Drivers and goals:

When developing cognitive maps, some concepts can be identified as having *overall influence* on the map. These concepts are known as *drivers* and typically have no other concepts influencing them or feeding into them. The key driver identified in this map is the external environment within which international NGOs operate. The extent of external volatility, whether it be economic volatility (influencing fundraising), political or even climate volatility (influencing programmes) has an overall influence over allocation decisions.

In contrast to drivers, a cognitive map's *goals* are concepts which ultimately are ends in their own minds, representing the objectives or overall aims of the situation that the map represents. In this cognitive map, three goals have been identified. The first is the ability of resource allocation decisions to promote organisational agility, allowing international NGOs to be responsive and adaptive in their environments. The second is related to programme performance, the goal of achieving sustainable, transformational change which is at the core of the overall organisational strategy. The third is shorter term programmatic goal, the degree to which immediate programme objectives are met, ensuring that allocation decisions are adequate to deliver current programmes and projects.

Feedback loops:

There are a number of feedback loops that are apparent in the cognitive map and these assist in anticipating the behaviour that could be simulated once the map is translated into a model. The first relates to the impact of earmarked funds and their ability, if unchecked, to have a reinforcing effect on allocation imbalances in the federation. For example, those country offices that benefit from earmarked funds, gain more experience in handling the requirements that are attached to earmarked funds and thus are more likely to be successful in receiving such funds in the future. This may cause a saturation of funds in a small number of country offices.

Another reinforcing feedback loop is evident in the relationship between the ability to raise unrestricted funds and the ability to drive sustainable change. For example, if there is an increase in unrestricted funds then the organisation has increased ability to allocate funds according to global programme objectives. This increases the legitimacy of their operations in programming areas, increasing their ability to gain more support from their local constituencies to drive sustainable change with beneficiaries. This ultimately leads to increased impact and the organisation's ability to deliver its strategy. This therefore enhances their brand recognition, thereby enabling more unrestricted funds to be raised.

Both of these loops related to the impact of earmarked funds on an allocation mechanism. This is further explored in the modelling process.

5.5.2 Considerations for model development

Based on the application of the SODA technique of cognitive mapping, the primary additional consideration for the model is revealed is the incorporation of earmarked funds into the allocation mechanism. Typically these funds are governed by separate processes and this hinders the line of sight across all related allocation processes.

In addition, earmarked funds can potentially impact the optimal allocation of funds. This also has the ability to influence the power dynamics of the organisation which is an important aspect to consider in a decentralised structure where decision making is collective. Even although formal power in a federal structure is decentralised through membership regulations, those country offices with more access to funds have access to an informal power that should be recognised. This is not incorporated into this modelling process but should be considered in future studies.

Finally, the cognitive map also revealed the importance of balancing the longer term strategic impact which, as described, has the ability to influence supporter acquisition and unrestricted fundraising, with the shorter term programme needs. Programme countries need to have a flow of reliable funds in order to ensure their annual programme objectives are met whilst not hindering the organisation's ability to be agile and responsive to external uncertainty. The system dynamics model aims to capture this requirement by incorporating of a set of "reserve" variables, allowing funds to be kept aside at both federation and country level for responsive reallocation.

5.6 Summary

The rich picture, coupled with the root definitions and CATWOE analyses of the three worldviews, provide some structure to the management descriptions of resource allocation gathered through the stakeholder interviews. The rich picture serves as a visual point of reference when creating the system dynamics model, ensuring that the core components and relationships are present. The root definitions also prove as useful references when validating the model's behaviour, ensuring that the model is behaving reasonably, generating sensible results.

The cognitive map, presented in this chapter, identified the different feedback loops present in current resource allocation mechanisms.

These insights, gained through the SSM and SODA analyses, will form the basis of the system dynamics model that will be developed and discussed in the next chapter. The purpose of the system dynamics model will be to simulate the effects of the above management challenges in a quantitative modelling setting and o investigate which variables or amendments, based on the root definitions and cognitive maps, result in interesting behaviour change in the model. The behaviour of the system dynamics model will then be analysed in relation to the key issues that were revealed in the stakeholder engagements.

Chapter 6

System Dynamics Model

6.1 Introduction

This chapter introduces system dynamics as the modelling approach in this study and articulates how key concepts identified in the problem structuring processes were chosen to be incorporated into the system dynamics model. This chapter describes the model's variables[1] and also discusses the assumptions that underpin the model and describes model's key features.

The generic model is used to develop management scenarios, testing a handful of management criteria which were identified during the stakeholder engagement and problem structuring processes. Ideally, the analysis and results would be shared with international NGO stakeholders, however, given the limited access to stakeholders towards the end of this study, this was not possible.

6.2 Introduction to systems dynamics

Sterman [2000] describes system dynamics as a method to better understand complex systems, enable decision makers to identify potential challenges and create policies that effectively guide such systems. Complex systems, especially dynamic complex systems, require more than our minds can often process, not because of a combinatorial complexity but because of a *dynamic* complexity [Sterman, 2000]. Dynamic complexity occurs when there are numerous interactions of systems over a long period of time [Sterman, 2000]. This is apparent in a number of real world systems. Sterman [2000] describes how one's limited mental capacity when dealing with such systems, often results in actions and decisions that fall short of the desired goal, or even worse, creating a negative result [Sterman, 2000].

6.2.1 Dynamic complexity

According to Sterman [2000], dynamic complexity is inherent in systems that are constantly changing with a high level of interdependency between their components. For example, man-

[1] A full list of variables, including their names, equations and descriptions can be found the Appendix.

agement and policy decisions are often taken in response to other concurrent decisions, resulting in different system behaviour. There is seldom a linear, one-to-one relationship between the various components of a systems and they are often impacted by lengthy time delays. These time delays mean that long term decisions are often based on short term information [Sterman, 2000].

The following subsections explain these core elements of a system dynamics model in more detail.

6.2.2 Feedback and time delays

Sterman [2000] stresses the importance of understanding the impact of feedback loops and time delays on systems. Each decision or policy amendment alters the state of the system and this often results in unintended effects that are not sufficiently scrutinised. The analysis of such feedback loops are usually tricky as the effect of these decisions are often not realised until years later [Sterman, 2000]. As such, a system can find itself "course correcting" only to end up somewhere entirely different. System dynamics takes into account these loops and delays, ensuring that side effects and delayed reactions are reflected along side desired goals as illustrated in Figure 6.1.

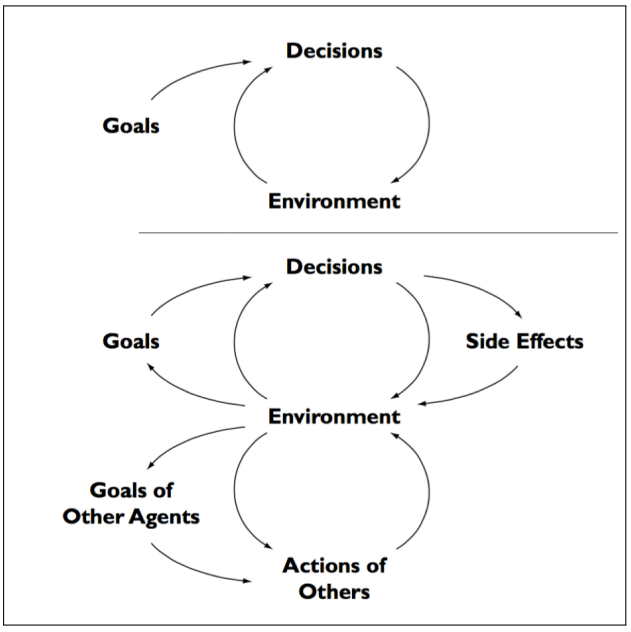

Figure 6.1: A system responsive to feedback [Sterman, 2000]

6.2.3 Stocks and flows

Another core concept in system dynamics modelling is that of *stocks and flows*. These are used to model the accumulation and dispersal of resources [Sterman, 2000]. A resource based view can extend beyond the traditional cash, inventory, equipment etc. to consider underlying accumulation of stock such as political capital and customer loyalty [Sterman, 2000].

Figure 6.2 provides an example of capital as a stock with the new investments as the flow in to the capital stock and the depreciation and/or consumption of capital as the outflow (a) as well as how a stock and flow is represented in the modelling software(b).

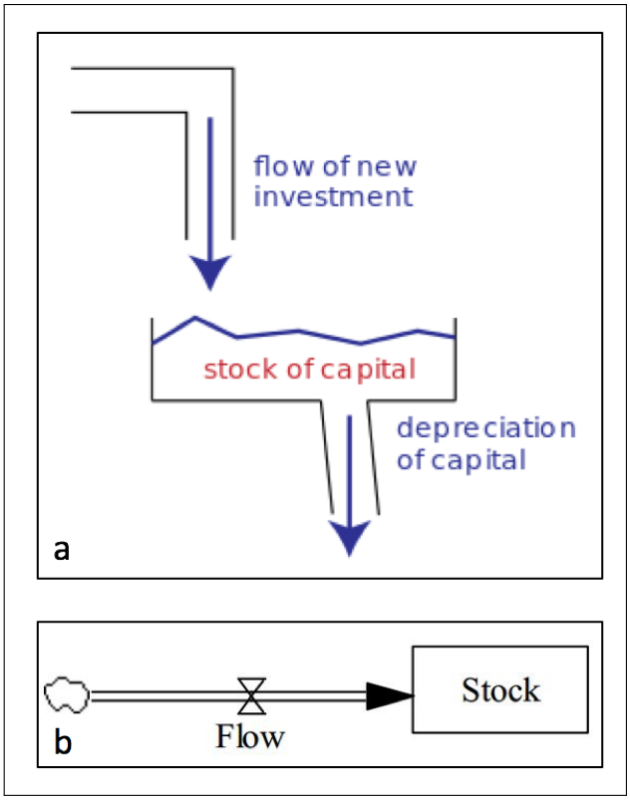

Figure 6.2: Examples of stocks and flows [Sterman, 2000]

Although both types of stock and flows are present in most systems, for the purposes of this resource allocation model, the stock that will primarily be analysed will be that of accumulated funds with the flows in and out of the stocks depicting the flow of funds. Other effects such as the influence of information or other decisions are represented as feedback loops, transforming and influencing other parameters and variables.

6.2.4 From mapping to simulation

In order to capture the dynamic complexity of a system, certain tools are used to incorporate the feedback loops into the modelling process [Sterman, 2000]. Feedback loops fall into two categories, the first is a *reinforcing* loop, amplifying a certain behaviour and the second is a *balancing* loop, self-correcting or counteracting behaviour [Sterman, 2000].

These feedback loops are typically uncovered during stakeholder engagement sessions and mapped through a cognitive or causal mapping process, as described in Chapter 5. Each system may contain many feedback loops and the mapping process is used to identify those that are most relevant. Computer simulation is used to analyse the resulting behaviour, i.e. the dynamic flow of stocks [Sterman, 2000].

A simulation model is created by transforming the causal or cognitive map into level (stock) and rate (flow) variables, represented by rectangles and "pipe" like connectors respectively as depicted in Figure 6.2b [Sterman, 2000].

Once the model is represented visually, each variable needs to have an initial set of conditions or parameters, usually estimates. Estimates are based on existing research, historical data, professional judgement and other sources. The model is simulated with these initial default parameters and the resulting behaviours are analysed. Parameters are then altered to gain deeper insights into the system to resolve issues and improve the system [Sterman, 2000].

The following section describes how the above has been applied to create a generic resource allocation model using Vensim PLE modelling software.

6.3 Resource allocation model overview

As presented in the previous chapter, exploring resource allocation within the international NGO context is a complex task. Each stakeholder brings a different set of perspectives, often opposing. Resource allocation within the federal context has the added burden of delivering global and local objectives in addition to the optimisation of resources.

Based on this, a system dynamics modelling approach has been used to create a a resource allocation model with the aim to illustrate the flow of funds through an international NGO with a decentralised structure. This model specifically aims to demonstrate:

- How funds are **pooled** across different types of markets within the federation.
- How funds are **allocated**, taking into account pre-allocation restrictions (for earmarked funds) and how flexible funds can potentially be used to balance any programme deficits.

Based on the above core processes, this model aims to investigate behaviour in relation to the following areas, as was highlighted by key stakeholders:

- The impact of combining **earmarked and flexible funds** into a single process, allowing earmarked funds to be offset by flexible funds where required and the impact of this **balancing effect**.
- The behaviour of **strategy performance**, taking into account pre-allocation restrictions (for earmarked funds) and how flexible funds can potentially be used to balance programme deficits.
- The behaviour of **reserves**, at various levels to provide a sense of the financial sustainability and affordability of the allocation framework.

The above behaviours will be investigated through the simulation of different management scenarios, altering different variables and parameters that may effect the performance of the overall model.

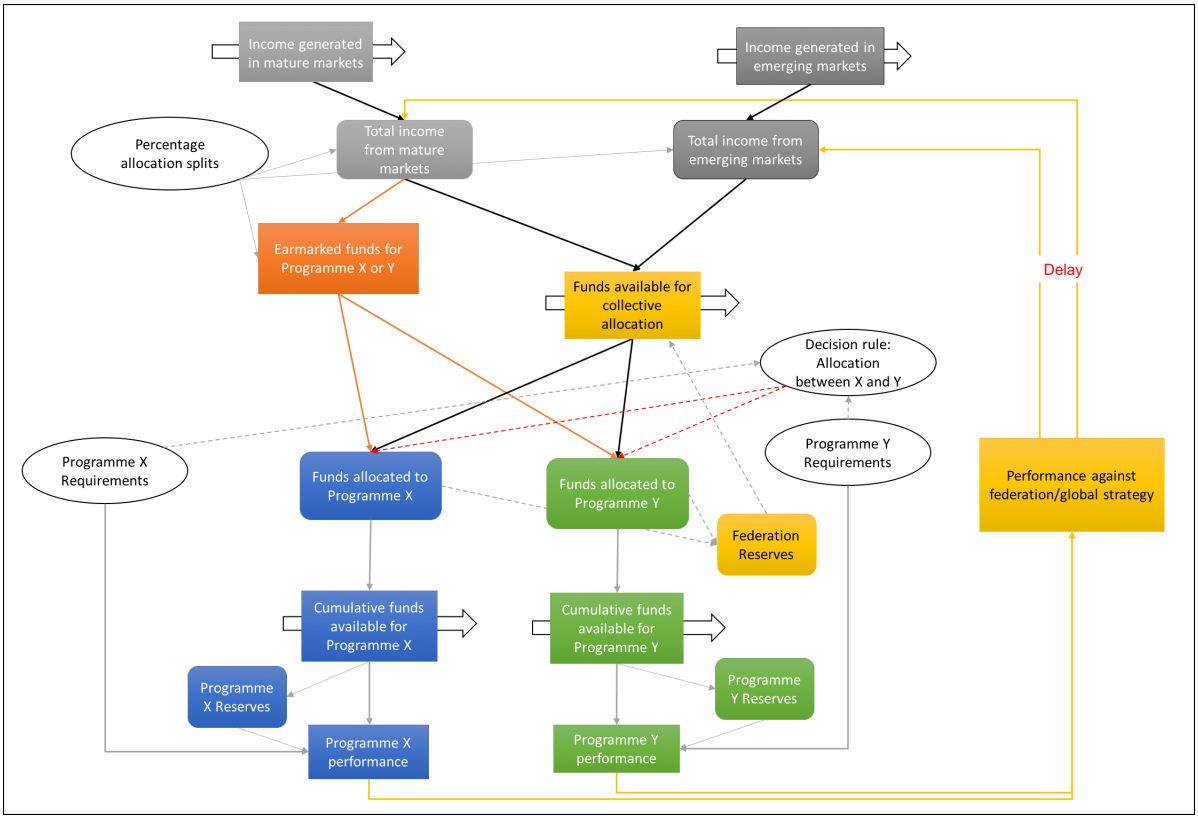

Figure 6.3: Illustration of income generated in the resource allocation model

The system dynamics model that was developed in Vensim PLE is depicted in Figure 6.4, however Figure 6.3 provides a simplified diagram for illustrative purposes, to support the written descriptions that follow.

As this is a generic model, the initial values of constants and other parameters have been set fairly arbitrarily, based on what would seem reasonable for a mid-size international NGO. The focus of the analysis is on the behaviour of the model in relation to "real life" resource allocation challenges, not solve a specific problem or identify specific values of parameters.

6.4 Model description

This section describes, in detail, the core components of the model with accompanying screenshots of the Vensim model. It is important to reiterate that this model is the simplest representation capturing the following key features:

- Two income generating variables generating two types of funds (earmarked and flexible)
- Earmarked funds are allocated to one of two Programmes (each with two different profiles)

- Flexible funds pooled for collective allocation to either of the two Programmes, depending on the size of the relevant deficit in each

- Programme performance is measured by the extent to which there is a deficit in either Programme

- Performance against strategy measured according to the combination of the two Programmes' performance

These key features are expanded upon in the following sub-sections. The model's time relationship is a rate over 1 unit of time, driving the level (rate) variable.

Note: Vensim variable names are included in italics in the descriptions below for ease of reference with the Vensim model in Figure 6.4. Also, a full list of variables, including their names, equations and descriptions can be found the Appendix.

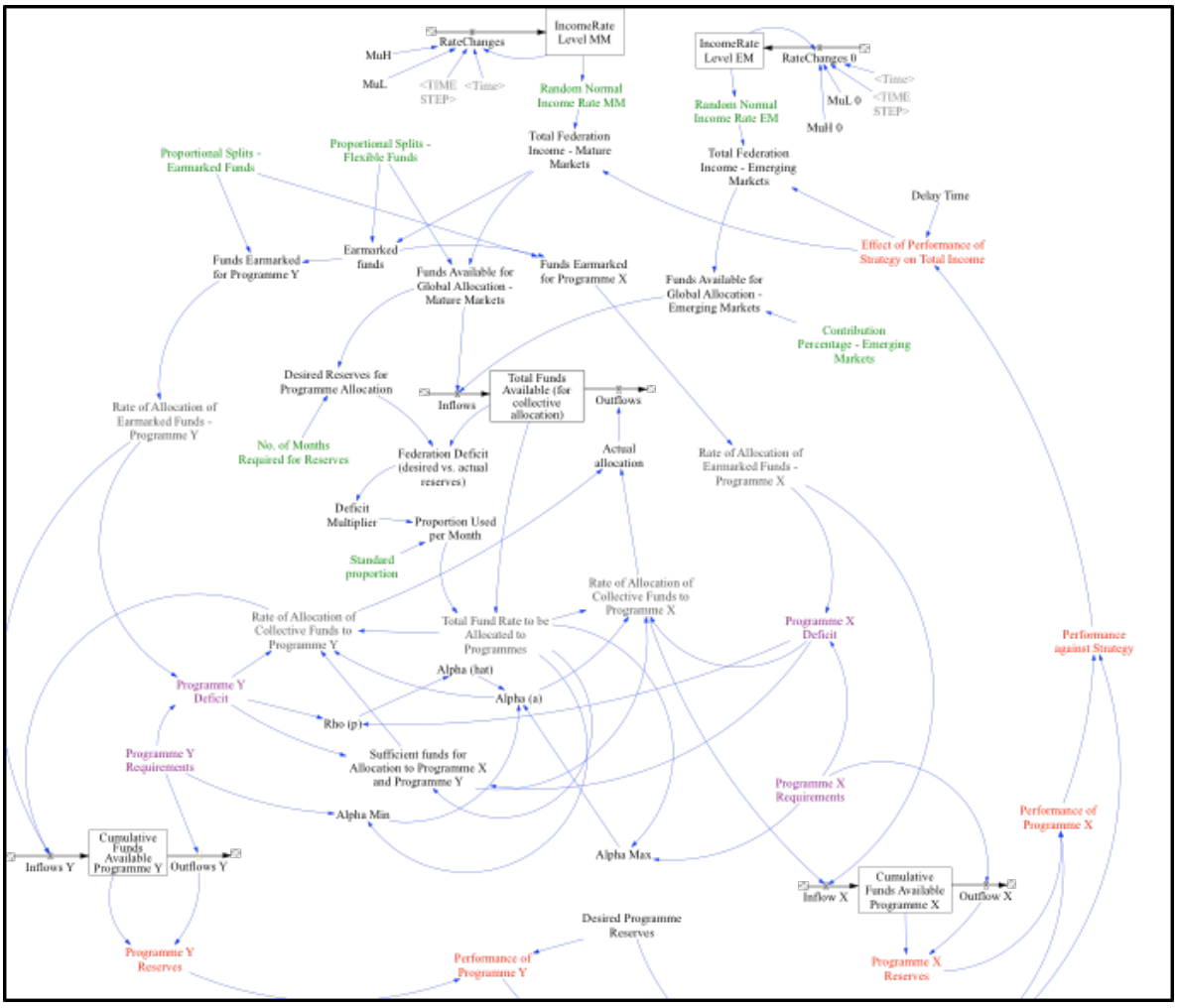

Figure 6.4: Generic resource allocation model

6.4.1 Income generation and funding types:

Two different income rates are generated, one representing income generated from emerging markets (EM) and the other representing income generated from mature markets (MM). This categorisation is chosen to illustrate the differing fundraising environments in these two markets as well as the trend of diversifying income sources through the expansion into emerging markets as per stakeholder discussions.

Both income rates are normally distributed (Variable[2] names: *Random Normal Income Rate MM* and *Random Normal Income Rate EM*) and include a random jump every five years (Variables: *Rate Changes*) to mimic external uncertainty as a result of political or economic fluctuations in fundraising markets such as a change in government aid policies.

Income generated in mature markets can be one of two types, either earmarked or flexible (Variable names: *Earmarked funds*, *Funds Available for Global Allocation - Mature Markets* and *Funds Available for Global Allocation - Emerging Markets*). Earmarked funds have a pre-determined allocation and therefore are not available for collective allocation and are directed towards a specific programme. In this simple model, there are only two programmes, **Programme X** and **Programme Y**, that receive earmarked funds. The second type of funds, flexible funds, do not have any pre-determined restrictions and can be pooled and allocated at the organisation's discretion.

In other words, funds raised in mature markets can be allocated in three different ways, depending on their type:

1. Income generated and earmarked for Programme X.
2. Income generated and earmarked for Programme Y.
3. Income generated that is unrestricted, or flexible and available for collective allocation.

The diagram in Figure 6.5 is a high-level visual of how funds are generated in the model. In Figure 6.6, the income generation and related variables are circled in red in the Vensim model.

[2] A full list of variables, including their names, equations and descriptions can be found the Appendix.

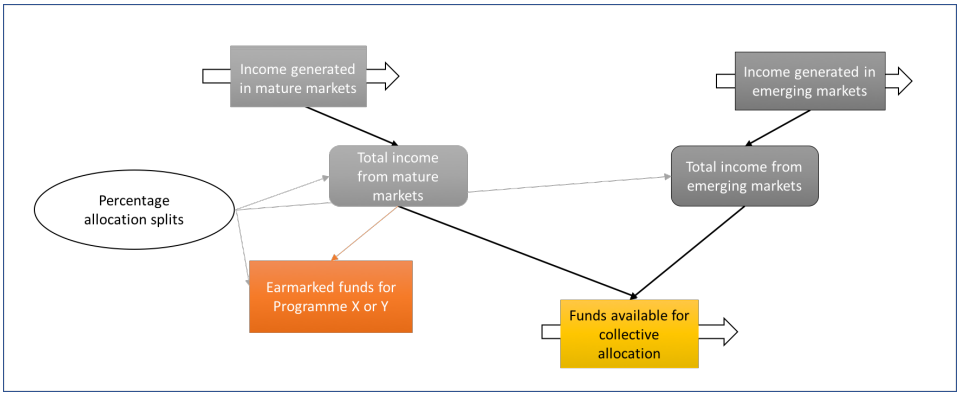

Figure 6.5: Illustration of income generated in the resource allocation model

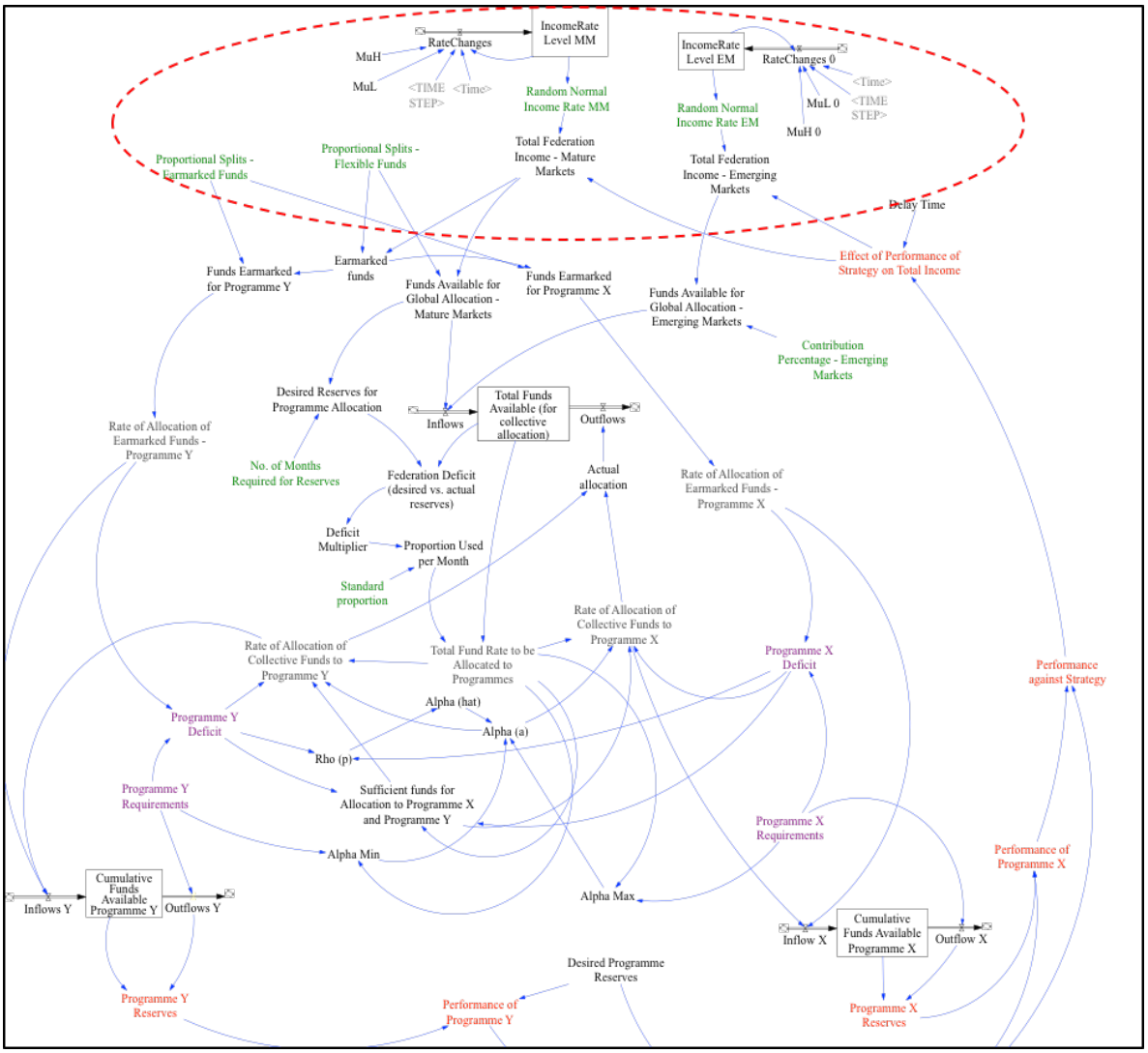

Figure 6.6: Income generation variables in the Vensim model

Flexible funds can be allocated to either Programme X or Programme Y (Variable names: *Rate of Allocation of Collective Funds to Programme X* and *Rate of Allocation of Collective Funds to Programme Y*) or for other federation allocation such as operational costs or investments or even other programmes. The initial percentage splits are set fairly arbitrarily.

Assumptions related to income generation and funding types:

- It is assumed that fundraising countries are solely responsible for generating funds.
- Only two types of funds can be generated. The first is earmarked funds which have a pre-determined allocation. The second is flexible/unrestricted funds which can be allocated at the federation's discretion.
- In reality, the above mentioned funds are usually neither completely earmarked nor completely flexible however for the purposes of the model, these two categories of funds will remain mutually exclusive.
- It is assumed that all funds generated in the emerging markets are flexible funds. This assumes that, in emerging economies, international NGOs are entering into fundraising activities and are generally exploring regular giving donations (individual donations) that are more flexible in nature.
- External uncertainties such as economic or political volatility are taken into account through the income generating rate variables. A step change is included for every 5 years, as this is the general time frame between potential political change (i.e. elections) which can lead to a change in a government's development funding strategy.

6.4.2 Funds available for collective allocation

The three level variables represent the funds available for Programme X, Programme Y and funds available for flexible allocation at any given point in time (Variable names: *Cumulative Funds Available - Programme X*, *Cumulative Funds Available - Programme Y* and *Total Funds Available*). Funds flow in and out of these level variables (stocks) on a monthly basis.

Not all flexible funds raised are available for allocation. A portion remains within the fundraising country office for their operational costs and other costs associated with fundraising. Most international NGOs have set percentages and calculations that indicates how the flexible funds are pooled.

This model applies a simplified "progressive tax" and assumes that mature markets raise the majority of funds and therefore contribute a larger percentage of their funds. The contribution percentages are initially set as two independent constants. These two percentages are applied to the flexible funds generated by emerging markets and mature markets determines the *inflow* into the middle level variable in this model, total funds available for collective allocation.

In Figure 6.7, the funds allocation and related variables are circled in red in the Vensim model.

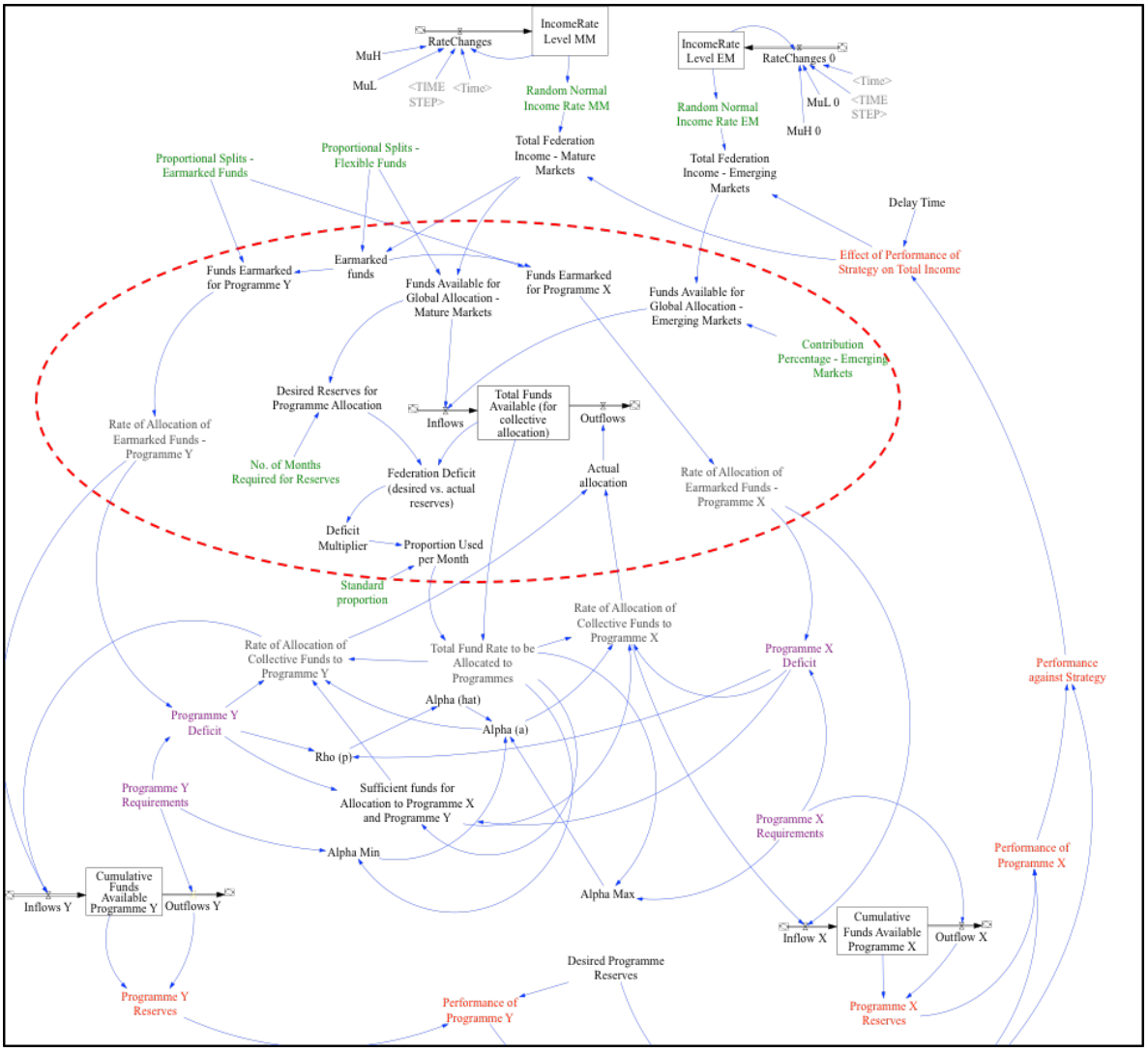

Figure 6.7: Funds allocation variables in the Vensim model

Assumptions related to funds available for allocation:

- The model considers funding flows on a federation level and not at a specific country or programme level.
- Not all flexible funds are available for collective allocation. A certain percentages remains in the fundraising country offices to cover overheads or other fundraising related costs.
- Earmarked funds are not available for allocation. *All* earmarked funds raised for either Programme *X* or Programme *Y* directly are allocated accordingly.

6.4.3 Programme allocation:

As mentioned above, the three level variables indicate the amount of funds available for allocation at any one point in time and are determined simply be subtracting the amount flowing out with the amount flowing in. (Variable names: *Cumulative Funds Available - Programme X*, *Cumulative Funds Available - Programme Y* and *Total Funds Available*)

The level variables determine the amount of funds available for allocation to Programme X and Programme Y and what should be held in reserve (Variable names: *Programme X Reserves* and *Programme Y Reserves*). The flexible funds available for collective allocation can be allocated to either Programme X or Programme Y depending on the relative shortfalls within each Programme (Variable names: *Programme X Deficit* and *Programme Y Deficit*).

For the purposes of this study, the features of Programme X and Programme Y are different. Programme Y has the characteristics of a larger, more stable programmes whilst Programme X has characteristics of smaller, more volatile programme.

In Figure 6.8, the programme allocation and related variables are circled in red in the Vensim model.

Assumptions related to programme allocation:

- Flexible funds can be allocated to either programme if there is a shortfall between funds and programme requirements, otherwise flexible funds are accumulated as federation reserves.
- Two programmes have been chosen (as minimally illustrative) for this study to explore, in a simple format, how flexible and earmarked funds interact and affect performance against strategy. Further extensions of the model, to more than two programmes can be considered in future studies.

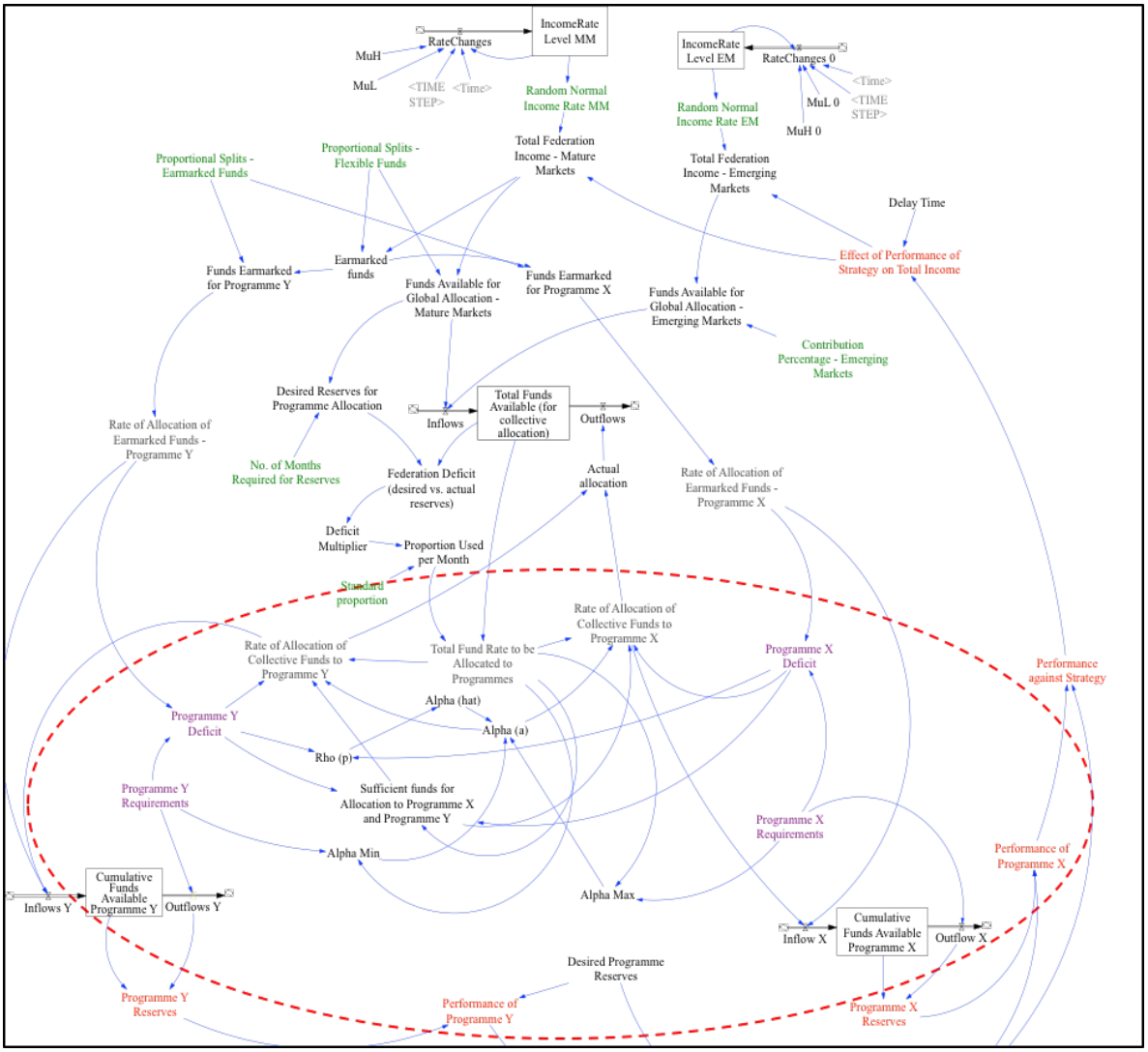

Figure 6.8: Programme allocation variables in the Vensim model

6.4.4 Programme deficits:

Deficit variables for Programme X and Programme Y have been defined and they compare the actual vs. desired reserves levels (Variable names: *Programme X Deficit* and *Programme Y Deficit*). This is converted it into a normalising factor which then drives the programming allocation proportion up or down in order to maintain an appropriate level of funds in reserve.

A desired reserves level has been set at two months, meaning that at any given time there should be at least two months of funds available for allocation (Variable names: *Desired Programme Reserves*).

Programme X and Y deficits are also used to inform how the flexible funds available should be allocated based on short falls within each Programme. A series of decision variables are used to compare the relative shortfalls for each Programme and allocates funds accordingly up to a maximum amount. If there are no short falls, flexible funds are added to federation reserves and available for federation operational allocation (Variable names: *Alpha*, *Alpha max* and*Sufficient funds for Allocation to Programme X and Programme Y*).

6.4.5 Performance against strategy:

The performance against the global strategy provides an indication of the *effectiveness* of this resource allocation model (Variable names: *Performance against Strategy*). This performance has a delayed effect of total income of the federation suggesting that better performance, means improved ability to raise funds and an increased likelihood of donors to donate to this INGO over another.

In this model, the level of performance is represented as the effective utilisation of funds, in other words, the extent to which programme funds available for allocation meets strategy requirements and requirements for Programme X and Programme Y (Variable names: *Performance of Programme X* and *Performance of Programme Y*). The variables representing strategy requirements and Programme X and Programme Y requirements follow an oscillating/sinusoidal function, at this stage independent from any other variables in the model (Variable names: *Programme X Requirements* and *Programme Y Requirements*).

The variable representing performance against strategy is normalised based on the difference between allocation and requirements across the two Programmes.

The federations' performance against its strategy has a delayed impact on the amount of total funds within the federation, in other words the performance against the strategy influences the federation's ability to raise funds. "Good" performance against strategy returns a positive number and, when applied to total federation funds, results in an overall increase. Similarly "bad" performance against strategy returns a negative number, thereby reducing total federation funds (Variable names: *Effect of Performance of Strategy on Total Income*).

The diagram in Figure 6.9 is a high-level visual of how performance against strategy is incorporated into this model.

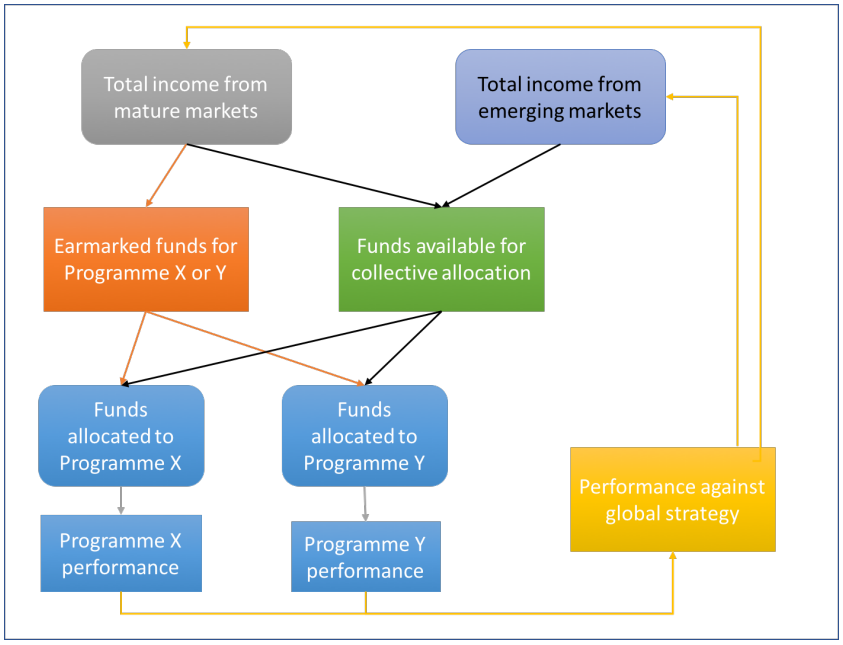

Figure 6.9: Illustration of performance against strategy in the resource allocation model

Assumptions related to programme allocation:

- Performance against strategy is only influenced by the programme performance in this model.
- Programme performance is based on the relative deficits or surplus of funds, based on the difference between desired versus actual reserves. This is normalized in order to compare relative deficits or surplus between Programme X and Programme. Y.
- Performance against strategy is determined, conservatively, based on the weaker of the two programmes.
- A delay of 24 months is included, as this is widely accepted as the time taken for "medium" term outcomes to materialise in a development initiative.

6.4.6 Measures of success for the model:

The effectiveness of the framework, represented in this model, will attempt to be measured against the following criteria, either explicitly modelled as outcome/goal variables in the model or by making inferences through the behaviour and trends of funding flows:

- Performance against strategy - maximising the ability for the international NGO to meet programme requirements.

- Financial sustainability - monitoring of reserve levels from the federation and individual programme perspective.
- Organisational agility - analysing the model's response to external uncertainty.

These will be further explored through the validation process and management scenarios in the chapters that follow.

6.5 Reflections on modelling process

A number of insights and lessons have been captured throughout the initial model development. These are summarised below and should inform future studies in this area:

Complexity exists in even the simplest of models: The process of transforming even one management concept into a set of variables is not a simple one-to-one relationship. One concept is made up of number of variables with different information inputs and outputs, all of which are ultimately represented algebraically.

Every arrow and variable has to contribute the model, a potentially daunting task when management strategies are often much broader and incorporation of an influencer without an understanding of the nature of the influence is not sufficient in a rigorous modelling process.

Modelling is an iterative process: There is no "final" version of a model, it is an iterative process and very much an interpretation of the modeller's understanding of the real world scenario being represented. A model can be tweaked and refined continuously, however it is important to identify an appropriate point in time to put a stake in the ground, even if its not perfect, and move on to analysis and interpretation of its behaviour and results.

Importance of stakeholder engagement during this process: A limitation of this study is the diminished stakeholder engagement during the modelling process. As this process is generally unfamiliar to management stakeholders, buy-in to the results and recommendations without a good understanding of the model development may hinder stakeholders' confidence in taking action and making decisions based on this study.

The following chapter will discuss the validation process that was applied to this model, to ensure that this model is fit for its purpose, structured logically and behaving reasonably.

Chapter 7

Model Validation

7.1 Introduction

"Usefulness with respect to purpose." [Forrester and Senge, 1980]

System dynamics has been critiqued as a modelling methodology because of the lack of emphasis on formal model validation processes [Barlas, 1996]. However, from a social sciences perspective, model testing and validation plays a far greater role in system dynamics than in other social sciences [Sterman, 2002]. System dynamics straddles qualitative system thinking and the formal modelling realms [Sterman, 2002]. This means that establishing a model's validity or usefulness with respect to its purpose, requires multiple lenses. It requires both qualitative and qualitative assessments on different data sets. Validation usually takes place at a set point in time within the modelling process but it is also important to use validation processes to continuously build stakeholders confidence from start to finish [Sterman, 2002].

The above does not provide a sneaky trap door through which to escape the rigours of testing and validation, however it does provide room for a flexible interpretation of validation.

Barlas [1996] describes a three-stage model validation process which provides a frame within which to build confidence in a system dynamics model's structure and behaviour, thereby building confidence in the results and recommendations of the model. This process has been applied to the generic resource allocation model and the results are discussed in remainder of this chapter.

Due to the limitations of first hand engagement with core stakeholders, this resource allocation model in this study is one of interpretation and by no means the "absolute truth". Rather, this model provides a learning opportunity, illustrating how system dynamics thinking and simple models can provide new insights into complex management challenges. It can also provide a mechanism for identifying longer term "unintended" effects of management policies in order to make more informed decisions in the future.

Since this model is a generic, simplified take on resource allocation mechanisms within international NGOs, validation is limited to theoretical comparisons, sense checking the model's logic against the cognitive maps in previous sections and light touch stress testing.

It is important to note that statistical significance testing will not be employed in the validation of this model. As is reasoned by Barlas [1996], the presence of correlated data and the notion of rejecting a null hypothesis (invalidating the model) do not assist in the establishment of a model's usefulness with respect to its purpose [Barlas, 1996].

7.2 Model structure validation

"A valid system dynamics model embodies the theory about how a system actually works within some respect." [Barlas, 1996]

7.2.1 Overview

Barlas [1996] stresses the importance of the validity of a model's **internal structure**. Confidence in a model has to be established in the model's logic before validity can be sought in a model's behaviour and functioning [Barlas, 1996]. Two types of tests are suggested when validating a model's structure, namely:

- **Direct structure tests** which studies the model's equations separately and makes comparisons against available knowledge. This test does not require simulation but makes comparisons against theoretical "accepted" literature or empirical data available from the real system that is being modelled [Barlas, 1996].
- **Structure oriented behaviour tests** indirectly assess a model's structure by applying a set of "extreme" behaviours and gauging the model's reaction in relation to the real life system. Barlas [1996] tests include setting extreme values for certain model parameters or identifying variables to which the model is sensitive and comparing these to behaviours of the real system.

7.2.2 Application to this model

The model in this study is based on key features and functionalities of resources allocation mechanisms in international NGOs. It provides a simplistic view on how funds are raised in different markets, pooled for collective use and allocated based on a set of basic decisions rules. It deals with two types of funds, earmarked funds that circumvent management decisions and flexible funds which can be allocated based on federation requirements.

In an effort to create confidence in this model's structure, the validation process refers back to the rich picture diagrams, root definitions and cognitive maps that were developed based on stakeholder interviews with a various individuals in the international NGO sector in Chapter 5.

The validation process also makes use of *Causes and Uses Trees* in Vensim. These trees can be generated for each variable, depicting how the different variables are influenced by one another in the model. These graphs will be used in the direct structure tests that follow.

Direct structure tests: Comparisons with root definitions

The first root definition articulated in Chapter 5 mentions the fundamental importance of collective pooling and allocation of resources in a federal structure and its ability to achieve a global strategy. This is represented in the model through the level variable *Total funds available for collective allocation*. The uses tree in Figure 7.1 depicts the collective allocation level variable and the other variables that it influences.

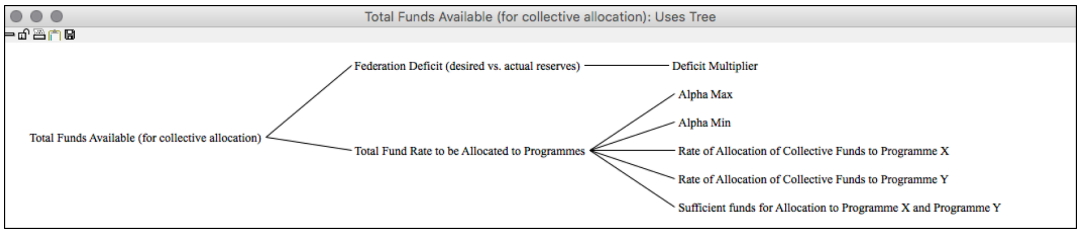

Figure 7.1: Uses tree for *Total Funds Available*

The second root definition considers allocation from a programmatic perspective, looking at the predictability of funds that flow through the allocation mechanism. The different reserves variables within the model provides insights as to whether this model is providing this predictability and the extent to which programmes are affected by this. The causes tree in Figure 7.2 also shows how the cumulative funds, flexible and earmarked funds, as well as the level of reserves, influences the programme's performance.

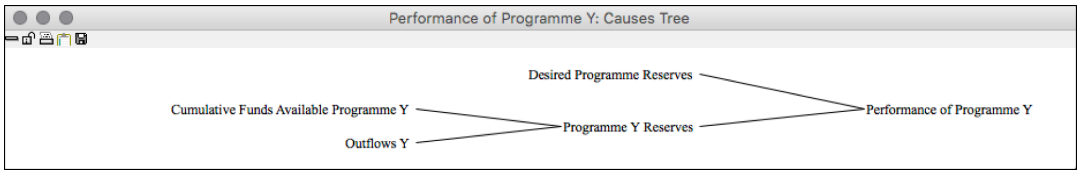

Figure 7.2: Causes tree for *Programme Y Performance*

The third root definition considers allocation from a fundraising perspective. The model should therefore reflect the uncertainties within fundraising environments. This is represented with the two input variables (drivers) that are normally distributed with a step change occurring every five years to mimic changes in political and financial environments in mature and emerging markets. Figure 7.3 shows the two primary influences on income being a delayed strategy performance and the effects of uncertain external fundraising environments.

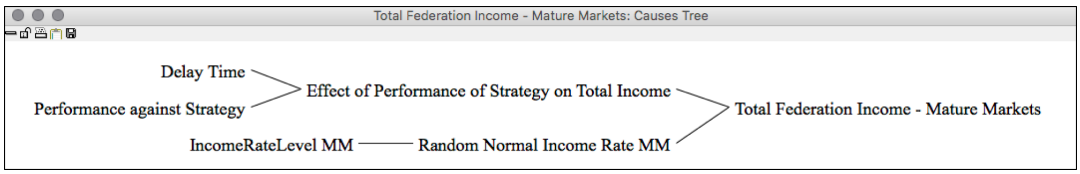

Figure 7.3: Causes tree for *Federation Income in Mature Markets*

Direct structure tests: Comparisons with cognitive maps

The most apparent feedback loop in the cognitive map in Chapter 5 is the effect of earmarked funds in the resource allocation model.

Currently, allocation mechanisms and related management decisions are focussed on flexible funds as management have a fundamental say over how these are allocated. This model considers how allocations may change if earmarked funds are considered and flexible funds are used as a balancing mechanism. This curbs the effect of the reinforcing feedback loop that is apparent in the cognitive map demonstrating that those country offices that benefit from earmarked funds, gain more experience in handling the requirements that are attached to earmarked funds and thus are more likely to be successful in receiving such funds in the future therefore causing more saturated funds in fewer country offices.

This balancing effect is incorporated into the model through a series of decision rules which proportionally allocate collective resources based on the comparable size of each programme's deficit. The causes tree in Figure 7.4 depicts the variables that determine funds flowing into Programme *Y*. This figure shows how the earmarked funds are augmented by the flexible funds through collective allocation.

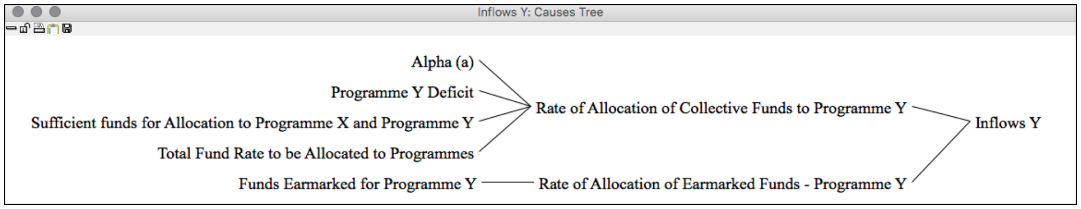

Figure 7.4: Causes tree for *Inflow of Funds into Programme Y*

The incorporation of flexible funds as a balancing mechanism was a specific question that arose during the stakeholder engagement sessions, as the degree to which this currently happens varies greatly.Therefore, stakeholders felt that the analysis of how this would (or would not) affect allocation decisions would be of interest. The behaviour of this mechanism is further explored in the behavioural tests that follow.

Structure oriented behaviour tests: Sensitivity and extreme value analysis

When applying extreme values to the variables that generate funds, the model reacts sensibly. Figure 7.5 shows how the increased volatility of income is similarly reflected in the allocation of funds to Programme *Y*. This sensitivity is in line with stakeholders' feedback in terms of the limitations of current resource allocation mechanisms. The magnitudes of the steps in the extreme value run for both the total federation income and total programme allocation variables are directly proportional in magnitude to the to the step changes in the income generating variables (random normal income rate variables). This is as expected as, in practice, the fundraising environments and any shocks or uncertainties associated with funds generation generally drives the behaviour of resource allocation mechanisms. Management decisions are required to put in place policies that will mitigate the impact on programme allocation, for example, reserve policies.

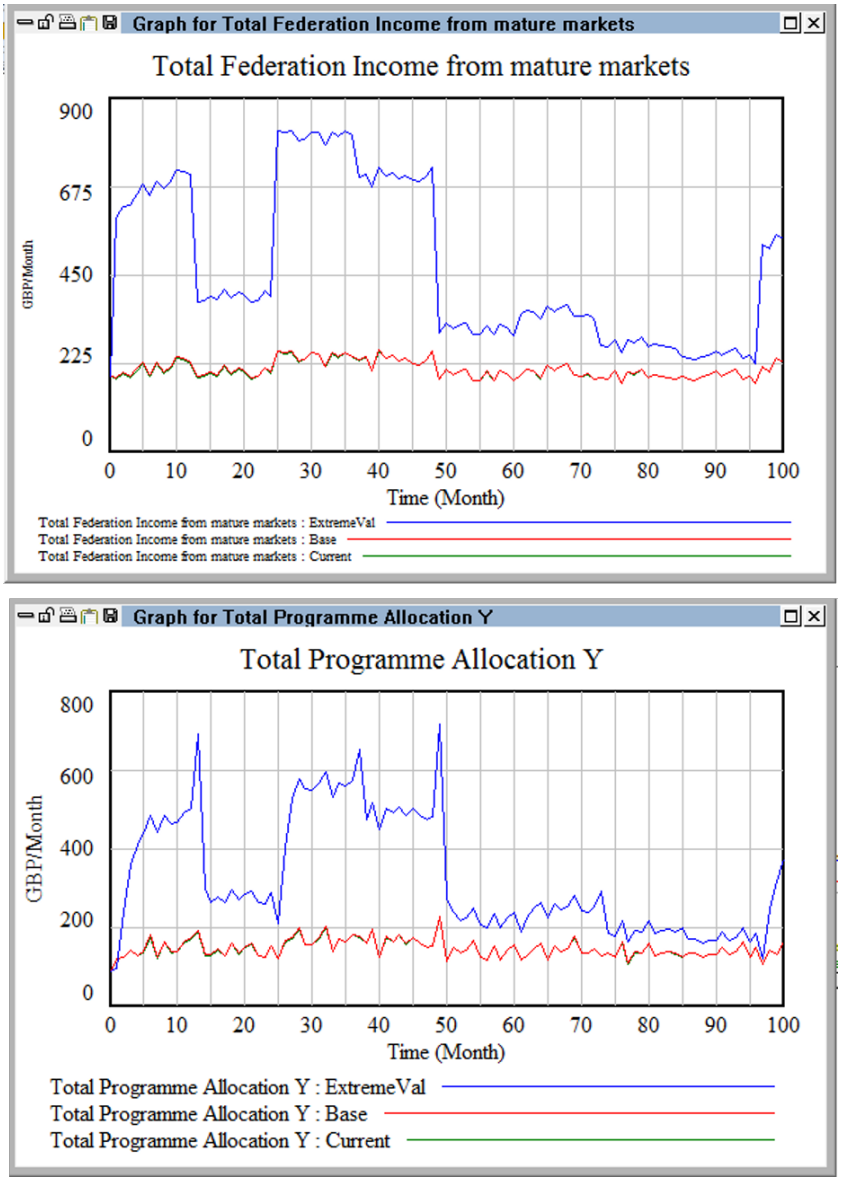

Figure 7.5: Model behaviour of federation income vs. programme allocation

Similarly, when applying extreme values to programme requirements, the model responds appropriately. In this instance, the requirements for Programme Y were increased by a factor of 4. This results in a steady downward trend for the cumulative funds available for Programme Y, as is evident in the top graph in Figure 7.6. The middle and bottom graphs in Figure 7.6 depict the inflow and outflow of programme funds respectively. The behaviour of the inflows (middle graph in Figure 7.6) largely fluctuate between 50 and 100, whilst the behaviour of the outflows (bottom graph in Figure 7.6) fluctuate between 800 and 900 which is why the cumulative funds available show such a steep downward trend, resulting in the programme running "into the red" fairly quickly.

Note that the model continues to run even although the cumulative funds available for the

programme run into the negative fairly quickly (top graph in Figure 7.6) which is why the inflows and outflows have constant fluctuations. In reality, a programme in this situation would not be left to its own devices and management intervention would be required to either find additional funds, reduce the scope of the programme or, in some cases, stop the programme altogether. Modelling the management response to such a programme running at a loss could be explored in future studies.

This second extreme value analyses supports the logic behind the collective allocation decision rules that are applied when a programme has insufficient earmarked funds. Although simple, these decision rules for allocation of collective resources provide an indication of how such a "balancing" mechanism may influence the behaviour of the overall model.

The above two extreme value analyses represent the major independent drivers in this model that are completely out of management control. Analyses of the other peripheral driver variables such as desired reserve levels, funding mix determinants and contribution percentages are explored in more detail in the next chapter through management scenarios as they represent potential levers of change within the model.

7.3 Model behaviour validation

"The right output for the right reasons." [Sterman, 2002]

7.3.1 Overview

Once the validity of a model's structure has been established, further assessments can be made on the model's behaviours to establish the model's accuracy in reproducing the real system's core behaviours [Barlas, 1996]. It is important to focus on the patterns of how different variables behave rather than specific points or values [Barlas, 1996]. As mentioned earlier, statistical tests do not always yield relevant information when attempting to establish validity in highly dynamic models with high levels of correlating data. Graphic representation for comparative purposes with real systems or accepted knowledge is seen to be an acceptable mode of validation in this instance [Barlas, 1996].

7.3.2 Application to this model

The ultimate goal for the resource allocation model, according to stakeholder feedback, is to maximise performance against strategy. It is therefore important to analyse the behaviour of this variable in the initial model. The causes tree for this variable in Figure 7.7 shows how the combination of resource allocation variables for both programmes as well as the programme requirements influence performance against strategy. Performance against strategy in this model is simply measured as the degree to which programme requirements are met with earmarked and allocated resources.

The behaviour of the programme performance and the strategy performance variables are primarily driven by programme requirements and the level of incoming funds in this simplified

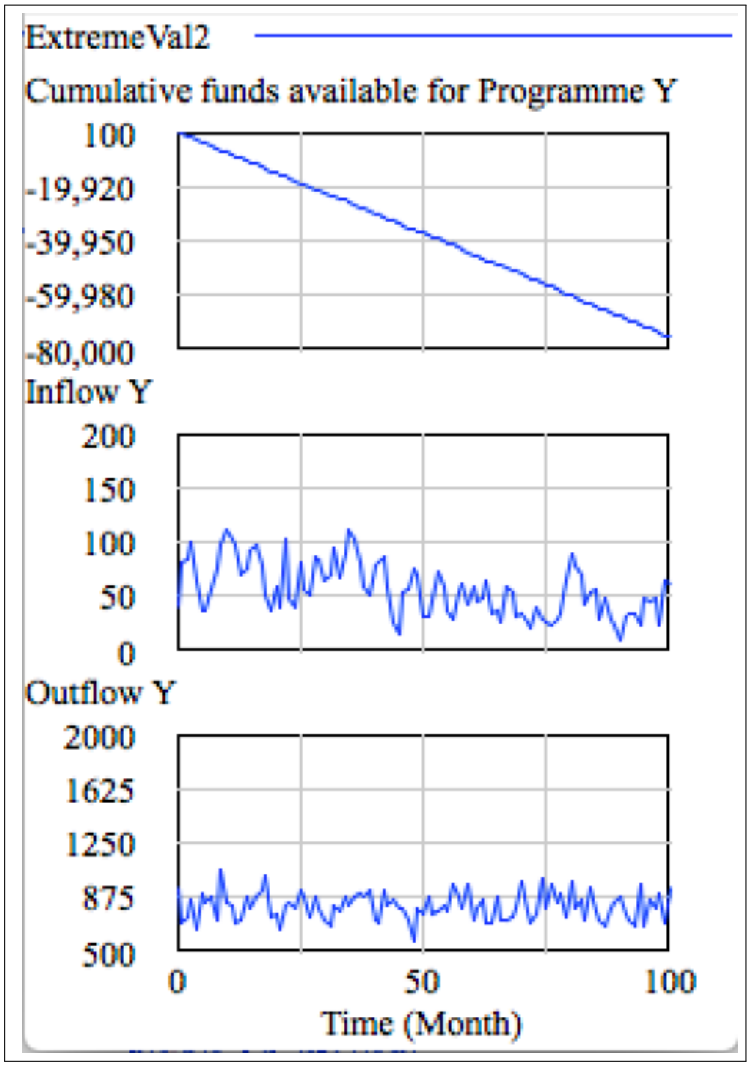

Figure 7.6: Model behaviour of *Allocation of Collective Funds between Programmes*

model. As such, from a qualitative management perspective, one would expect that the performance related variables would respond positively to higher levels of incoming funds, in other words, increased funds result in increased performance. On the other hand, with all other variables remaining the same, one would expect that higher programme requirements that cannot be met by the current funds available, would result in decreased performance. These qualitative presumptions were simulated in the initial model to test whether the model's results are comparable in four different runs.

Note:

- Performance against strategy, in this instance, is presented somewhat conservatively equating to the weakest programme performance between Programme X and Programme Y.
- The x-axes in Figures 7.8 and 7.9 represent the relative deficits/surplus of funds, based

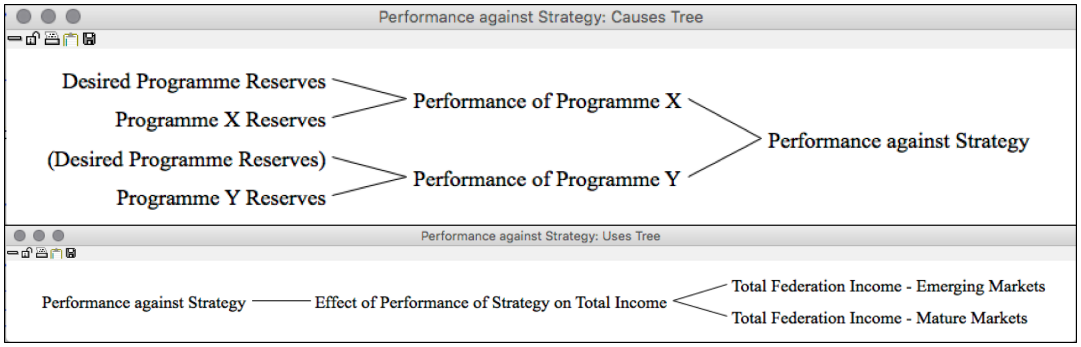

Figure 7.7: Causes and Uses trees for *Performance against Strategy*

on the difference between desired versus actual reserves. This is normalized in order to compare relative deficits or surplus between Programme X and Programme Y. Performance against strategy is determined, conservatively, based on the weaker of the two programmes.

Run A - The impact of increased funds with high programme requirements on performance variables:

The funds generating variables were increased until there was a behaviour change evident in the performance related variables. This meant that the funds generated in mature markets variable was increased by a factor 10 and the programme requirement were increased by a factor of 4. The resulting behaviour in the performance variables is depicted the top graph in Figure 7.8, showing that all three performance variables (the two programme performance variables and the overall performance against strategy variable) repeatedly **under-perform**. The reason for this is the programme requirements have been set so high in this run that they are never met and the resulting behaviour of the performance variables are thus always negative (because the requirements are always larger than the funds available for each programme).

Furthermore, due to the assumed characteristics that Programme Y's requirements are much higher than that of Programme X (as described in Section 6.4.3), this results in a consistently lower performance for Programme Y. Since the overall performance against strategy is determined (conservatively) by the lowest performing programme, this means that at any point in time, performance against strategy is equal to that of Programme Y's performance. In fact, you cannot see Programme Y's behaviour (green line) at all in the top graph of Figure 7.8 as it is overlaid by the overall performance against strategy behaviour (blue line).

Run B - The impact of increased funds with low programme requirements on performance variables:

In this run, the programme requirement variables were reset to their initial lower values (i.e. reduced by a factor of 4) whilst the funds generation variables remained high. As expected, the resulting behaviour in the performance variables, depicted in the bottom graph in Figure 7.8 quickly reaches "optimal performance" as programme requirements are repeatedly met due to the increase magnitude of available funds.

Run C - The impact of decreased funds with high programme requirements on performance variables:

In Run C, the funds generation variables are set back to their original values, (i.e. reduced by a factor of 10) whilst the programme requirements are increased by a factor of 4. The resulting behaviour of the performance variables, depicted in the top graph in Figure 7.9, shows that the decreased funds coupled with the higher programme requirements result in decreasing programme and strategy performance. This is as expected as there are less funds available to meet programme requirements and thus the year-on-year shortfalls culminate in decreasing performance over time.

Similarly to Run A, due to the assumed characteristics that Programme Y's requirements are much higher than that of Programme X (as described in Section 6.4.3), this results in a consistently lower performance for Programme Y. Since the overall performance against strategy is determined (conservatively) by the lowest performing programme, this means that at any point in time, performance against strategy is equal to that of Programme Y's performance. In fact, you cannot see Programme Y's behaviour (green line) at all in the top graph of Figure 7.8 as it is overlaid by the overall performance against strategy behaviour (blue line).

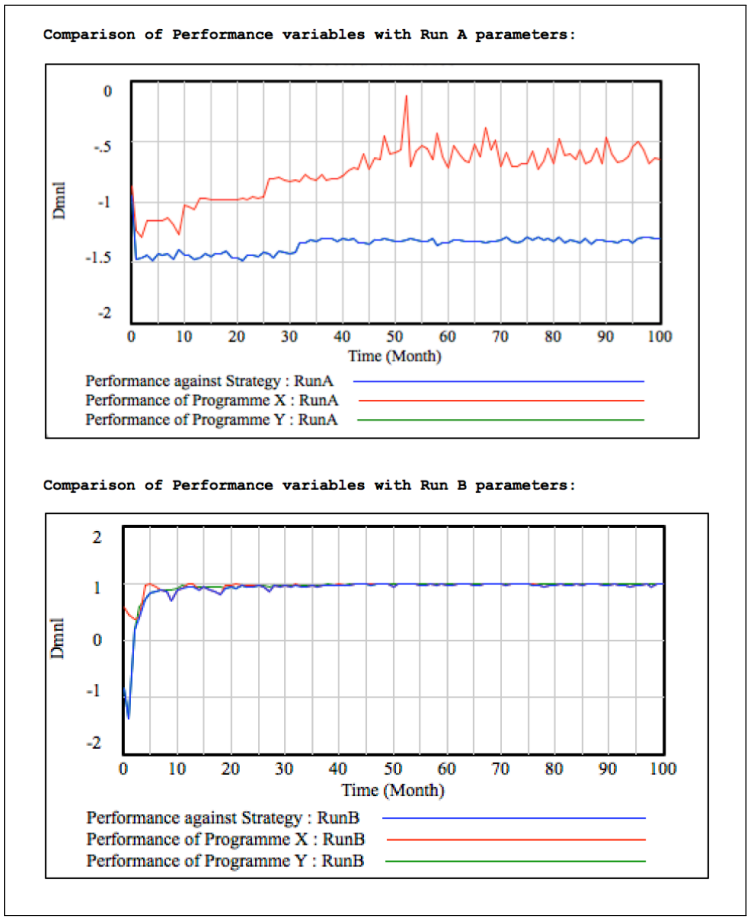

Figure 7.8: Behaviour of Performance variables in Run A and Run B

Run D - The impact of decreased funds with low programme requirements on performance variables:

In the final run, the funds generation variables are kept at their original values, (i.e. reduced by a factor of 10) and the programme requirements are also set back to their original values (i.e. reduced by a factor of 4). The resulting behaviour of the performance variables is depicted in the bottom graph in Figure 7.9. This figure shows that the decreased funds coupled with the lower programme requirements result in an increased programme and strategy performance, reaching "optimal performance" after 20 months which is as expected as the available funds are sufficient to meet the programme requirements.

The above combinations validate the core behaviours of this simplified resource allocation model as they reinforce management's expectations of the flow of funds and the impact on the performance variables. This analysis is further explored through the management scenarios in the next chapter.

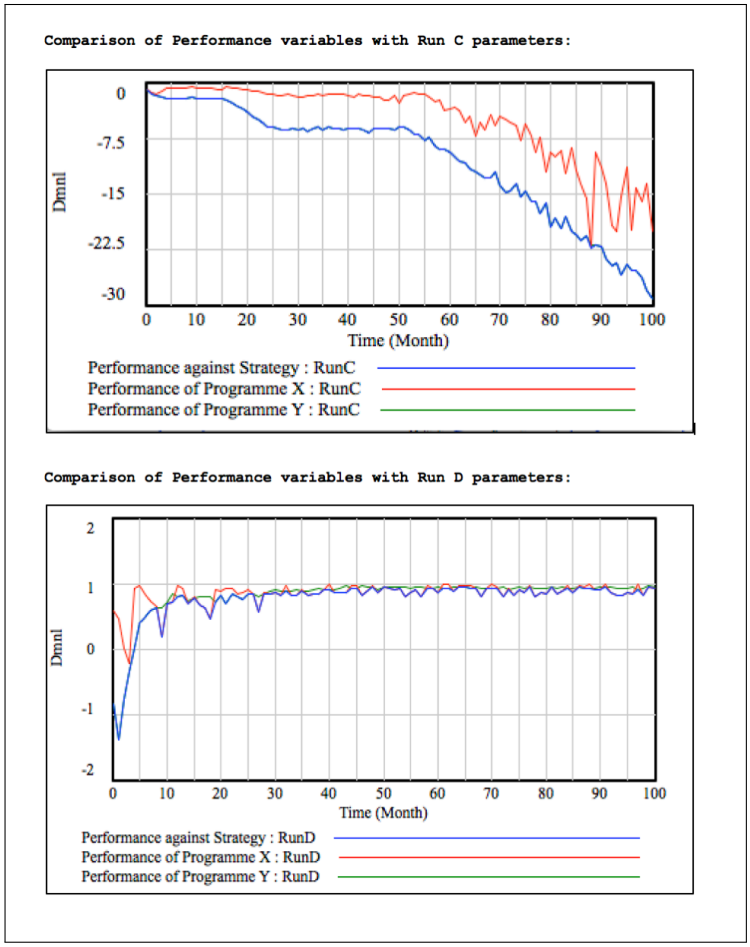

Figure 7.9: Behaviour of Performance variables in Run C and Run D

7.4 Reflections

The model validation tests conducted in this chapter, although light touch, show that this resource allocation model's structure is largely representative of the core components of resource allocation mechanisms as described by stakeholders during the various interviews and engagements. For example, the root definitions that were developed in Chapter 5, presenting stakeholder feedback through three core lenses (programmatic, fundraising and federation) are reflected in the model's structure.

The model is also reflective (in a simplified manner) of the current external and organisational contexts that were revealed through the cognitive mapping exercise, for example, in the incorporation of uncertainty in the funds in funds generation and the allowance for management policies such as reserves.

Finally, this model allows for one expansion, namely the incorporation of earmarked funds, as a decision making criterion, into the resource allocation process. A simplified decision rule to allocate funds according to relative shortfall of funds was included in the model. The sensitivity and extreme value analysis showed that the flexible funds are allocated accordingly when programme requirements are varied. This was an explicit outcome of the stakeholder engagement processes and its incorporation may generate insights as to how such a model would deal with these variables in real life.

It is worth repeating that the purpose of this model and this study is to *learn* about how resource allocation mechanisms, simplified as it may be, act in a systems dynamic environment and this could potentially reveal new insights in management decisions in relation to this. As such, the above validation is considered satisfactory in this instance, but additional tests and increased engagement with a wider subset of stakeholders should be considered if any of the results or insights be practically incorporated into INGOs or other organisations:

For example, the root definitions and cognitive map should be workshopped with the INGO's full management team, including representation from diverse country offices (smaller vs. larger offices with different funding and programming mixes etc.). In addition, a financial representative, or an individual(s) with deep knowledge of the INGO's financial position, should be included in the modelling and validation processes to ensure that a more detailed model's structure and behaviour is an adequate representation of their specific resource allocation reality in relation to the INGO's historical financial and fundraising data. Once this model is deemed sufficiently "valid" for management decision making, more substantive stakeholder engagement is required to gain buy-in into the model so that resulting changes are accepted and owned *within* the INGO, therefore establishing the model's credibility with stakeholders is a necessity.

In the chapter that follows, a series of management scenarios will be explored, building on the initial model, outlined in Chapter 6.

Chapter 8

Management Scenarios

8.1 Introduction

With the generic resource allocation model validated for the purposes of this study, three management scenarios are simulated. The generic model, as outlined in Chapter 6, is used as a "base model" and the amendments of each scenario are applied, simulated and analysed.

For this study, the term "scenario" is loosely used to refer to the revised model with amendments based on the characteristics of the scenario. This revised model is simulated and the resulting behaviour analysed to evaluate differences, translating these into insights that may be relevant from a international NGO management perspective.

This chapter begins by outlining the scenario selection rationale, detailing why certain scenarios are of interest in this specific study and highlights the model amendments required for simulating each scenario. The remainder of the chapter explores each scenario, the specific amendments to the model's structure and the resulting behaviours and implications from a management perspective.

It is important to note up front that the analyses that follows provide "snapshots" of how the model behaviour's changes based on discrete amendments. These scenarios/amendments are not the only ones, nor even the best ones to consider. However, they attempt to provide *illustrative investigations* given real life resource allocation challenges as described by stakeholder, demonstrating how system dynamics modelling can help management, rather than solving a specific management problem.

A more exhaustive investigation, for example considering combinations of scenarios and applying different functions to various variables within the model are beyond the scope of this study and could be considered in future studies.

8.2 Overview and scenario selection rationale

Numerous perspectives and scenarios can potentially be considered when analysing this resource allocation model.

Core model components	**Real world representation**	**Model amendments**	**Simulation analysis**
1. Income generating variables	Generates income in two markets - mature and emerging markets; includes volatility to illustrate external uncertainties	Increase or decrease variability in current variables; change the function type of an income generating variable	The extent to which the model is responsive to this volatility will test the robustness and agility of the mechanism
2. Percentage allocation parameters	Determines the amount of funds that can be collectively allocated; determines the percentage split of flexible vs. earmarked funds	Increase or decrease allocation percentages; vary the percentage splits between earmarked and flexible funds	These adjustments will test the affordability of the model and the extent to which different combinations of flexible funds vs. earmarked funds impact the model's performance
3. Decision rules that govern collective allocation of flexible funds	Represents one very simple management rule to allocate collective funds	Current decision rules based on the relative programme requirements; additional variables can be added to further influence the allocation of flexible funds, for example, strategic investments variables	Consider the effect of additional influencing factors to see whether collective allocation as a balancing mechanisms remains effective
4. Reserves and deficit variables (programme level and federation level)	A proxy for financial sustainability, with two to three months reserves considered optimal	Reserve levels remain unchanged; model extensions can consider how excess reserves can be utilised or collectively allocated	No change for simulations, reserve levels are treated as an indicator of financial sustainability rather than a management lever for change
5. Programme requirements	Determines the extent to which funds are allocated to different programmes within the resource allocation framework; based on needs/demands	Incorporate influencing factors based on the resource allocation framework e.g. historical allocations patterns	No change for simulations; in future this can provide insights into how fundraising and/or other organisational strategies can unduly influence allocation
6. Performance against strategy	A proxy for the effectiveness of the allocation framework; compares programme requirements and programme funds available; this variable also influences (with a delay) the ability to raise future funds	Performance against strategy remains unchanged; serves as a performance indicator when the different scenarios are investigated	No change for simulations; however the changing behaviour of this variable will be observed throughout the simulation process

Table 8.1: Summary of potential model amendments for simulation

Table 8.1 aims to summarise the various different scenarios and amendments that can be explored, based on stakeholder feedback and the management experiences of the author. The table is categorised according to six core components that constitute the generic model in Chapter 6. Each of these core components (sets of parameters) are explored, investigating the types of simulations that can potentially be applied and the anticipated model amendments required to generate the respective scenarios.

Analysing 8.1 and considering stakeholders' feedback and their initial interests in such a modelling process, the first three line items in the table will be formulated into scenarios for this study. The remaining three, included for completeness, can be considered in future studies.

Each of these different scenarios, not to mention combinations of scenarios, can and should be considered in future analyses. However, for the purposes of this study, the first three line items in Table 8.1 are considered sufficient for further investigation in this dissertation. After all, the purpose of dissertation is to examine the feasibility of the system dynamics modelling approach. The features of the first three scenarios in Table 8.1 represent the key concerns of stakeholders and will be used to illustrate how such a modelling technique may be useful in providing example insights. However, a more thorough analysis would be required in the future should an INGO management team wish to practically apply any recommendations to their organisational contexts.

The remainder of this chapter explores the first three scenarios, as mentioned above, in Table 8.1 through individual simulation and interpretation of results. The purpose of which is to investigate the different types of decisions that would trigger different behaviours in different variables and what combinations of parameters would yield optimal (or at least improved) model behaviour based on a set of management criteria discussed during stakeholder engagements.

The three scenarios that are explored in this study consider the following variations:

Management scenarios:

1. Volatility of income generated versus predictability of income available for allocation
2. Varying proportions between flexible funds versus earmarked and the effect on fundraising contribution percentages
3. Changing the decision rules on how flexible funds are allocated and its effect on balancing allocation between Programme X and Programme Y

Below are two Figures 8.1 and 8.2 that show which areas of the model will be manipulated in each scenario.

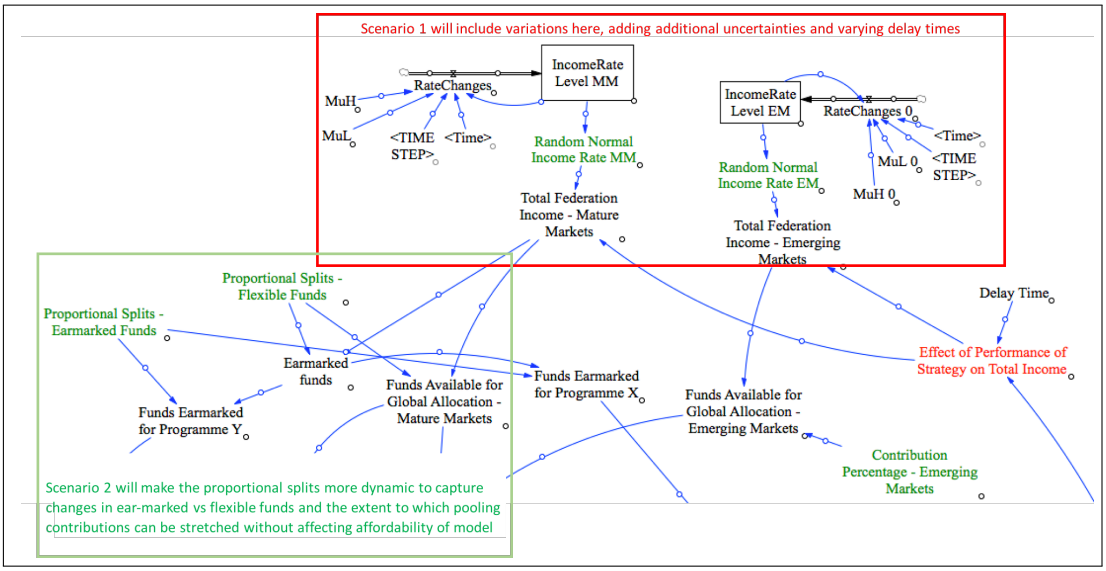

Figure 8.1: Simulation focus areas

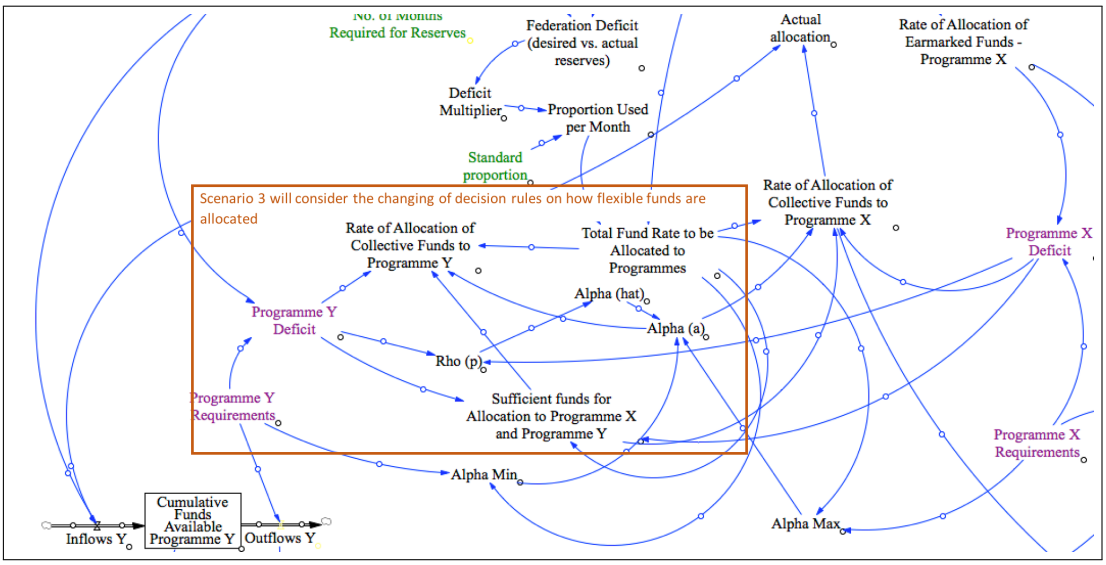

Figure 8.2: Simulation focus areas cont.

The experiments and adjustments to the model will be considered from the following aspects:

- Performance against strategy, an explicit variable in model
- Financial sustainability, monitoring behaviour of reserves variables
- Organisational agility, monitoring how long it takes for the mechanism to balance after an external shock

8.3 Scenario One

Volatility of income generated vis-á-vis predictability of income available for allocation

The concept of volatility has both positive and negative connotations, depending on context, resource availability, organisational agility and personal preference. However, for the purposes of this scenario, in the context of generating funds for NGOs, increased volatility is undesirable. Income volatility was a consistent concern from the stakeholders who contributed to this study. This is substantiated by [Hudson, 2015] who explores the link between aid volatility and aid effectiveness and how unexpected deficits can cause potential imbalance and overcorrection.

Since this model is primarily concerned with the *effectiveness* of resource allocation, it therefore seems acceptable to surmise that higher volatility in income would have a negative effect on the ability to meet programme requirements, negatively impacting the overall performance against strategy.

The volatility that is experienced in this context, is typically as a result of external uncertainty in fundraising environments. According to the ActionAid and Greenpeace annual reports between 2014 - 2016 [Greenpeace, 2017] [ActionAid, 2017], political and economic climates in the traditional fundraising countries in Europe, combined with diversification strategies (fundraising investment in emerging markets) has resulted in slower income growth as well as sharp disruptions due to exchange rate volatility. This has an impact on programme implementation, hindering the ability for programmes to accurately plan and manage projects.

8.3.1 Model Amendments

The above motivation is translated into specific model amendments and these are detailed in Table 8.2.

Variable Name	Amendment	Explanation
Random rate (mature markets)	Incremental increases of the mature markets volatility by doubling the variance of the underlying normal distribution	Explore the extent to which incremental increases in volatility affect performance against strategy
Income rate (emerging markets)	Replace uniform function with a logistics curve which will determine the mean, average, income rate for this variable	Explore the effect of a non-linear income rate on allocation behaviour
Income rate (mature markets)	Vary the size and timing of the step change, which determines the average size of income, when generating the the income rate in mature markets	Exploring the effect of changing the magnitude and timing of the external “shocks” in fundraising contexts

Table 8.2: Scenario 1: Model amendments for increased income volatility

As previously mentioned, predictability of income for programme implementation is crucial. This scenario, therefore, aims to explore the extent the pooling and balancing mechanism in the model absorbs and/or distributes the disruptions and volatility in order to minimise the effect on programme implementation.

It is important to note that the degree to which variables are increased or decreased have been chosen fairly arbitrarily, it is the relative model behaviour that is of most interest and not the specific values of constants as this is a hypothetical model.

8.3.2 Simulation Results

When increasing the volatility of the model with the above model amendments the resulting behaviour of key variables were as follows:

Increased volatility of income generated in mature markets:

The two graphs in Figure 8.3 compare the effect of the incremental increase (by a factor of 2) in the standard deviation of the random normal function that is used to generate income. The top graph in Figure 8.3 depicts the behaviour of income in mature markets. The mean for this function is determined by the step function that makes a random change every 12 months, this determines the predominant behaviour. The three simulation runs show a proportional increase in variations with Run 1, with the lowest standard deviation, having the smoothest behaviour whilst Run 3, with the higher standard deviation (four times that of Run 1), having a more volatile behaviour.

The effect of these changes on performance against strategy is seen in the second graph in Figure 8.3. It is evident from this graph that the behaviour is primarily responsive to the mean behaviour of the income variable. The increase in standard deviation has minimal effect on performance against strategy in the first 24 months. Towards the end of the simulation, where the mean income decreases, the higher standard deviation does have a slight negative effect on performance against strategy.

When considering intermediate variables such as the federation and programme deficits, increasing the volatility of income generated in mature markets did have an effect. This is evident in the two graphs in 8.4. However through the allocation mechanism, this effect was reduced as is evident when looking at the project deficit levels. The federation deficit is more responsive when the volatility results in a sharp decrease in income. This results in a sharp drop in federation deficit levels. These sharp drops are not as apparent in the Programme Y deficits.

This can potentially be attributed to the effectiveness of the allocation mechanism in balancing out this volatility with project requirements. However, the behaviour of the programme deficit variable is more responsive to the mean income behaviour. This will be further explored when the parameters for the mean income for mature markets is varied in another simulation.

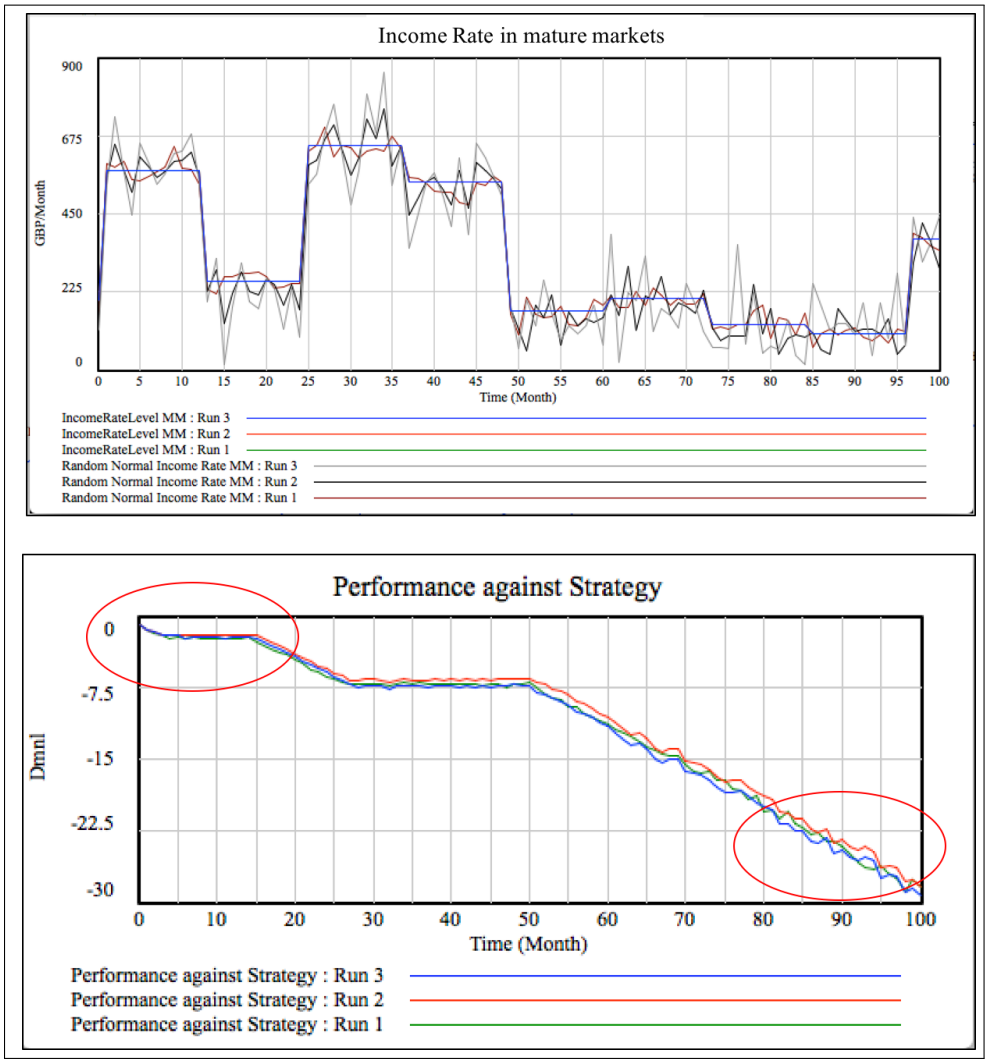

Figure 8.3: Effect of increased income volatility on performance against strategy

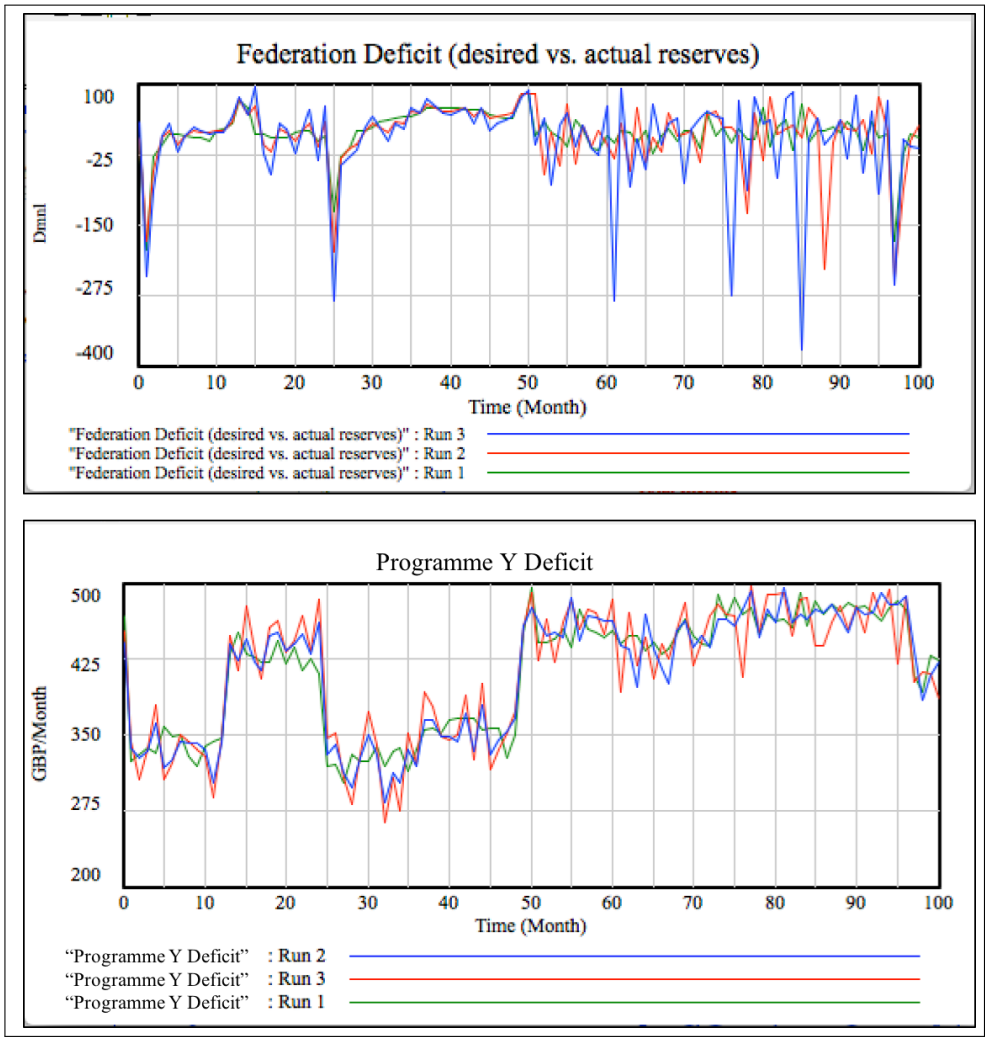

Figure 8.4: Effect of increased income volatility on Federation and Programme deficit levels

Increased growth of income generated in emerging markets:

A logistics curve is applied to income generated emerging markets with three simulation runs depicting a progressively increased gradient. These changes are directly reflected in magnitude and timing when considering the cumulative funds available for Programme X in Figure 8.5. This is largely due to the fact that the income generated in emerging markets is flexible and Programme X does not attract a large amount of earmarked funds. This means that the cumulative funds for Programme X mimics the behaviour of flexible income generated.

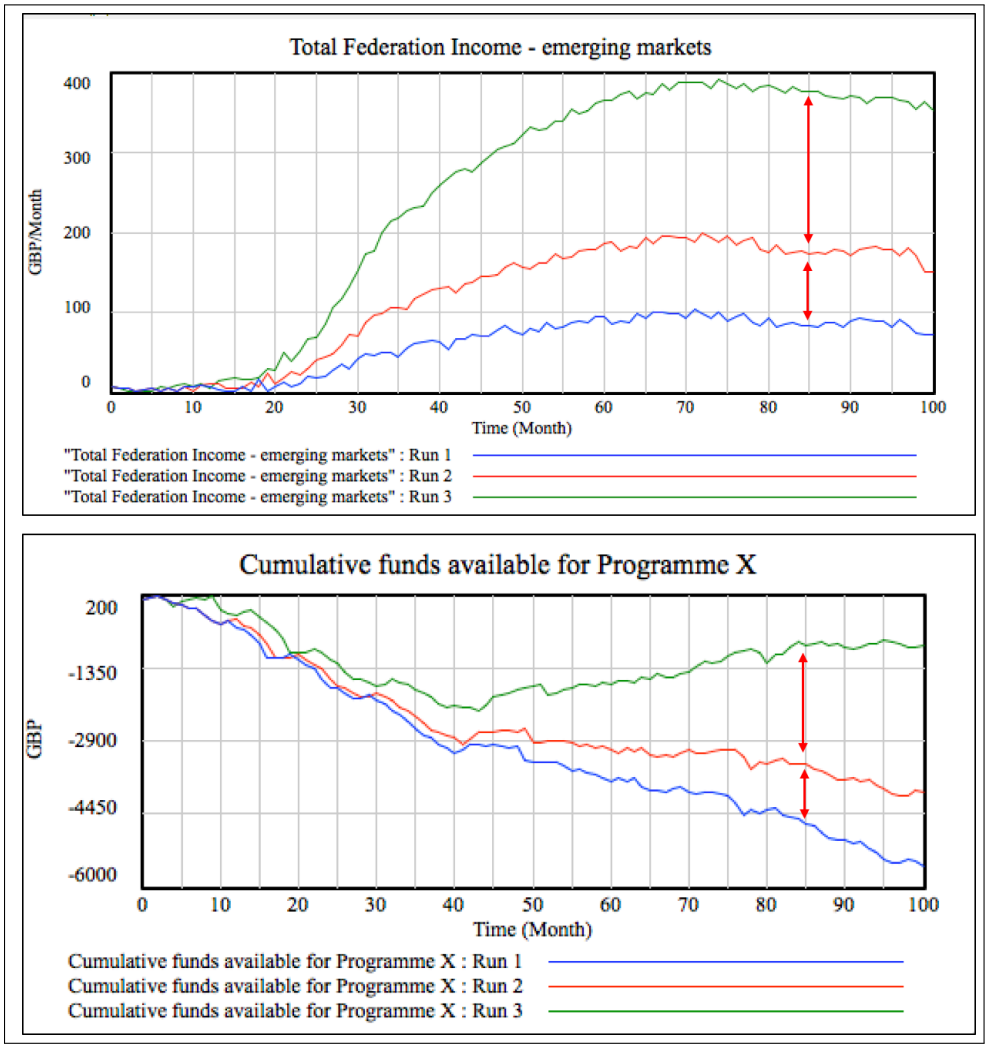

Figure 8.5: Effect of non-linear income rate on programme funds

Varied mean for income generated in mature markets:

The mean used in the random normal function to generate income in mature markets is based on step function that moves up or down every 24 months. In this scenario, the magnitude and timing are adjusted to create three different behaviours. Figure 8.6 shows the behaviour of the function with its initial parameter settings in run 1 (green). The second run (red) shows a lengthier timing between step changes and the step changes have smaller magnitude, which creates "smoother" behaviour. The third run (blue) has more frequent changes with a larger magnitude.

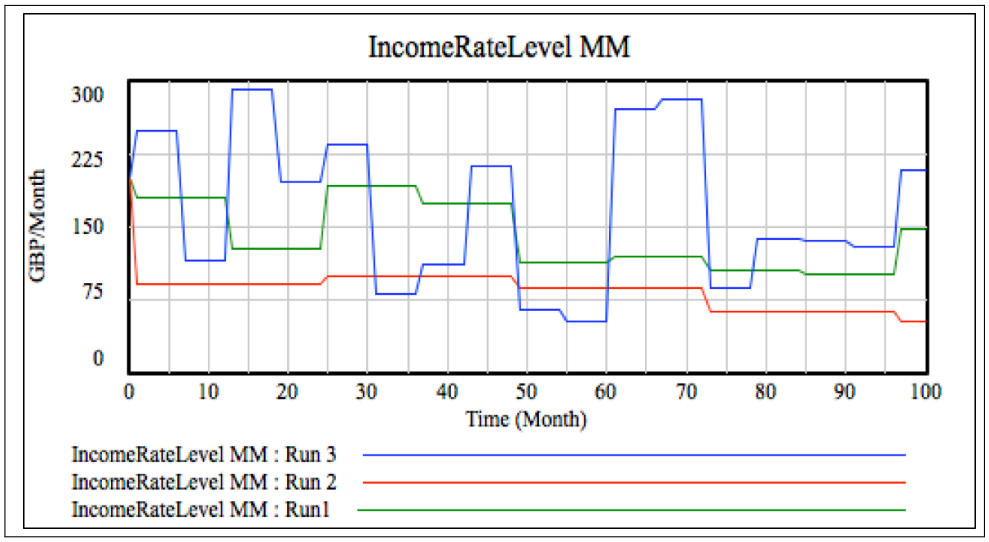

Figure 8.6: Effect of varied mean of income generated in mature markets

The effect of these changes is analysed through the behaviour of programme cumulative funds and programme reserves depicted in figure 8.7. The first graph in this figure shows the effect of the change in mean income on cumulative funds available for Programme X. The "smoother" behaviour has a negative effect on the amount of cumulative funds, this effect gradually increases over time. Even although the difference in means between months 70 and 90 for run 1 and run 2 are similar, the effect on the cumulative funds between the same time period shows an increasing difference.

In the second graph in Figure 8.7 the programme reserves also seem to be more sensitive to the smoother income behaviour with an increased frequency of sharp drops in reserves. Even although the change in mean is more frequent and higher in magnitude in run 3, the allocation mechanism seems to be able to take advantage of the higher mean with programme reserves only being affected towards the end of the time period.

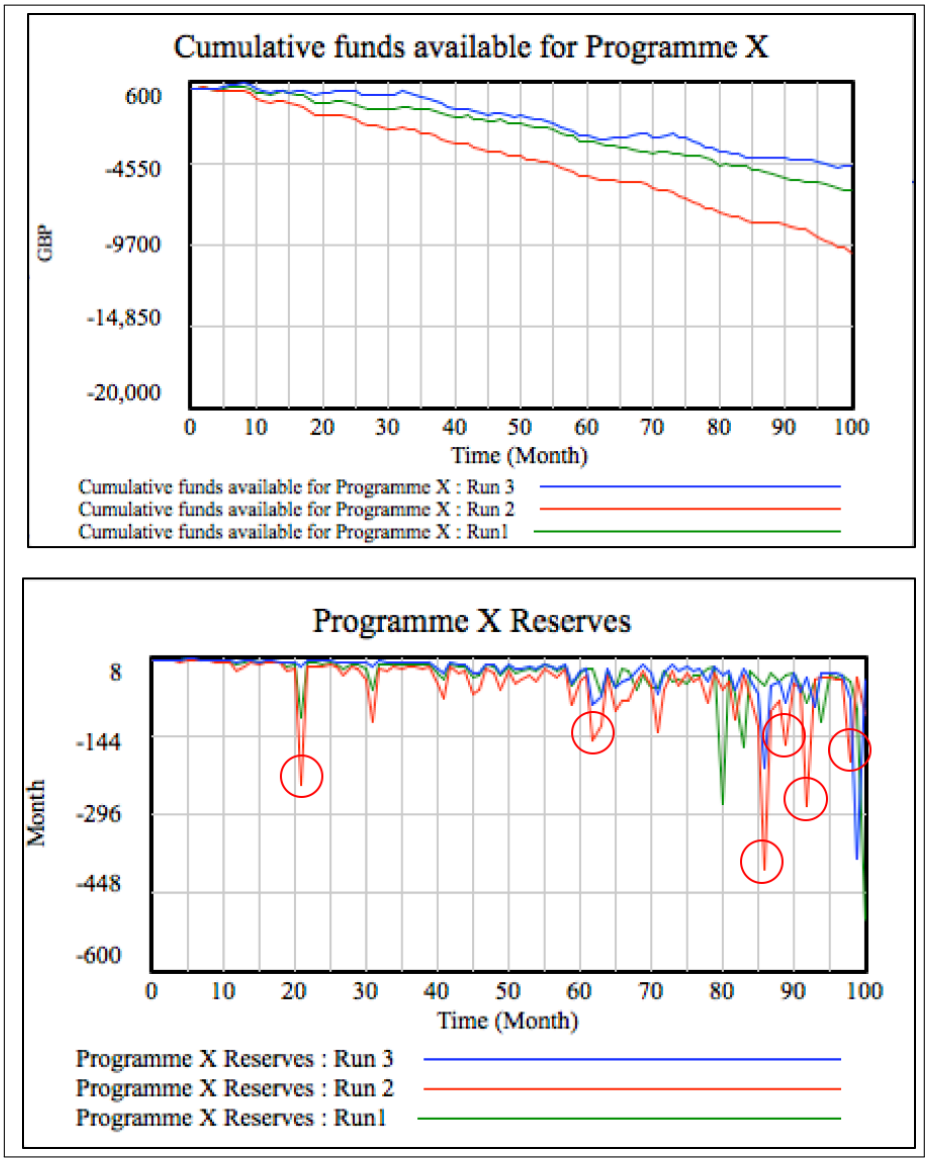

Figure 8.7: Effect of varied mean on programme funds and reserves

Reflection on Scenario 1:

This first scenario looks to explore how income volatility and different types of income distributions impacts the predictability of income at programmatic level. For INGO management, this is critical from a programme planning perspective, especially in cases where programmes run over multiple years. System dynamics provides an opportunity for INGO managers to simulate the effects of such volatility and to test out different policies and parameters that could reduce the impact of programmatic and strategic performance over the long term.

Even a simple system dynamics model such as this can generate numerous management insights, identifying triggers and trends to assist INGO management when they structure their resource planning and allocation processes, or other management mechanisms.

For example, in this scenario, the balancing mechanism in the resource allocation model seems to moderate the additional changes and volatility in the income generating variables. The federation bears the brunt of the volatility and this limits the knock on effect on programmes and projects, providing more predictability at the programme level. This is particularly apparent in Figure 8.4 where the volatility of the programmatic deficits is attenuated compared to that of the federation deficits. Although this is likely to be desirable, affording programmes more predictability in income, the effect of this at federation level (top graph in Figure 8.4 may also need to be compensated to avoid the sharp drops in reserves, with an increasing frequency over time. Such insights are important as it indicates that a change in strategy may be needed between 40 and 50 months (3 to 4 years) in relation to resource planning and allocation.

Another point for consideration in this scenario could be in relation to performance against strategy. In this instance, performance against strategy responds proportionally to the changes in the mean of the income generating variables, however the variance of the income generating variables has almost no effect. It is only when the volatility directly influences the *the magnitude* of funds available, in other words results in a step change in the mean, that the behaviour of the performance variables responds as was evident in Figure 8.3. This type of an insight could be, for example, used to influence funding diversification strategies to minimise the over-reliance of funds in one country or one type of of fundraising environment.

As was described in Secton 2.4, the development landscape is becoming increasingly complex and INGOs, as key players, need to be able to adapt their strategies and structures in response to this. Modelling approaches such as system dynamics could prove extremely helpful in exploring different options for change whilst minimising disruption of their current programmes.

It is worth repeating that these are simple illustrations of the power of system dynamics when applied in this context. Future studies could consider incorporating additional influence from other variables (e.g. federation deficits) to extend this scenario and test the extent this to which volatility is absorbed in the model.

8.4 Scenario Two

The *types* of funds that international NGOs raise are often closely linked to their strategy and identity. Securing flexible funds is generally preferred as this allows an organisation to allocate funds in line with their own strategies rather allocation based on donor or other external strategies. However, these types of funds tend to be in smaller amounts, received by individual givers. Earmarked funds, especially in the form of grants, are generally larger and for specific programmes. A set of criteria is used to structure how the funds can be spent, in terms of which programmes and also types of activities within a programme.

In this scenario, the *funding mix* will be varied, to explore the effect of certain combinations on performance against strategy and the federation reserves. Three combinations will be considered, firstly predominantly earmarked funds, secondly predominantly flexible funds, thirdly an equal mix of earmarked and flexible funds.

This scenario will also consider the effect of a different mix funding types on the *collective contribution percentages*. The generic model makes the assumption that only flexible funds can be pooled as earmarked funds are preallocated. Furthermore, the generic model, assumes

that there is one fixed contribution percentage applied across all flexible funds (refer to Section 6.4.2). If the contribution percentage is set too high, this could incentivise fundraising countries to prioritise raising earmarked funds, on which no contribution percentage is applied. This could mean that the model would not be affordable to fundraising countries and would result in a limited ability for the federation to have flexible funds for strategic investment or other priorities.

This scenario will consider the effect of the three different funding mixes and will look at the combination of 3 different contribution percentages (high, medium, low) applied to flexible funds and the effect of this on performance against strategy.

8.4.1 Model Amendments

Based on the above rationale, specific amendments which have been incorporated into the generic model are described in Table 8.3. This scenario aims to explore the effect of varying proportions of flexible funds and earmarked funds on total federation contributions and if contribution percentages should be adjusted to maintain acceptable federation reserve levels.

Table 8.3: Model amendments for varying types of funds

Variable Name	**Amendment**	**Explanation**
Mature markets percentage split earmarked vs flexible funds	Three combinations are considered; firstly 80 percent earmarked funds and 20 percent flexible funds ; secondly 80 percent flexible funds and 20 percent earmarked funds; thirdly an equal mix, 50 percent, for both types of funds	Exploring the effect of the three different funding mixes on performance against strategy and federation income levels
Variations in contribution percentages for global allocation (refer to Section 6.4.2)	Varying the contribution percentages (high - 80 percent, medium - 50 percent and low - 20 percent) that is applied to the flexible funds	Exploring the combined effect of the different contribution percentages and the different funding mixes on income levels and performance against strategy

It is important to note that the degree to which variables are increased or decreased are set fairly arbitrarily. It is the model behaviour that is of most interest and not the specific values of constants as this is a hypothetical model.

8.4.2 Simulation Results

When varying the funding mix and contribution percentages of the model with the above model amendments the resulting behaviour of key variables were as follows:

Effect on federation income:

The three simulation runs represent three different funding mixes. Run 1 reflects an 80 percent flexible funding mix, Run 2 has a balanced mix of 50 percent flexible funds and 50 percent earmarked funds and Run 3 has an 80 percent earmarked funding mix.

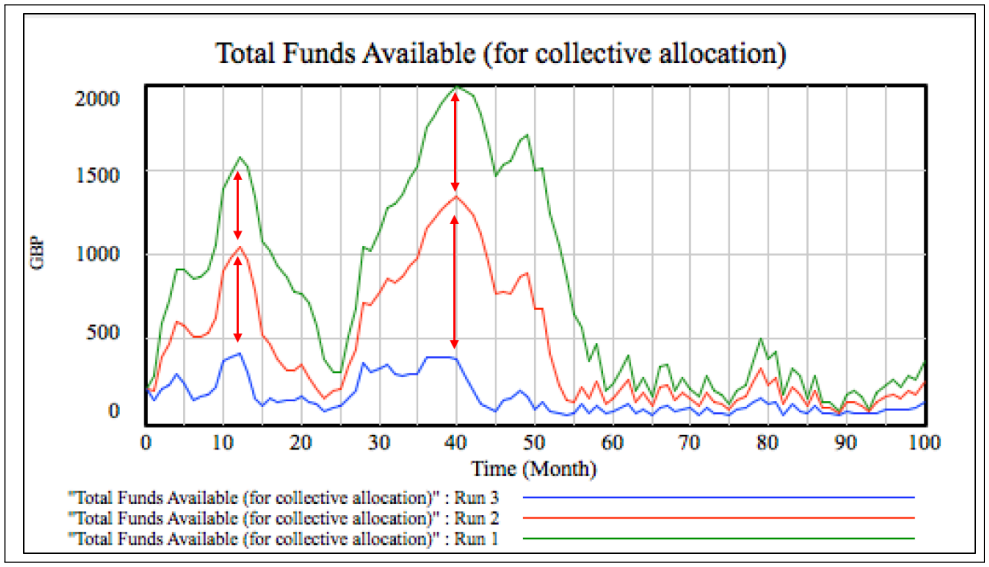

Figure 8.8: Effect of varied funding mixes on total funds available for collective allocation

As is expected, the increase in proportion of earmarked funding in the federation funding mix does reduce the overall funds available for collected allocation as is evident in the in Run 3 in blue Figure 8.8. The overall behaviour of total funds available, however, is still primarily responsive to the behaviour of the incoming generating variables. This is evident in the the two "peaks" at month 10 and month 40 that are a direct result of increase in overall income generated. As is expected, a higher proportion of flexible funds (Run 1 in green in Figure 8.8) does result in more funds available for collective allocation, and the increased magnitude is proportional to the percentage increase of flexible funds vs. earmarked funds.

This behaviour is not as evident when considering the federation deficit. Run 3 in blue in Figure 8.9 shows that the a predominantly earmarked funding mix results in more resilient reserve levels in the longer term.

Although all three runs show similar behaviour, a predominantly flexible funding mix (Run 1 in green in Figure 8.9 has the largest magnitude of negative reserves after month 50. This could mean that long term fundraising strategies should be revised at least every 5 years if an organisation raises mostly flexible funds.

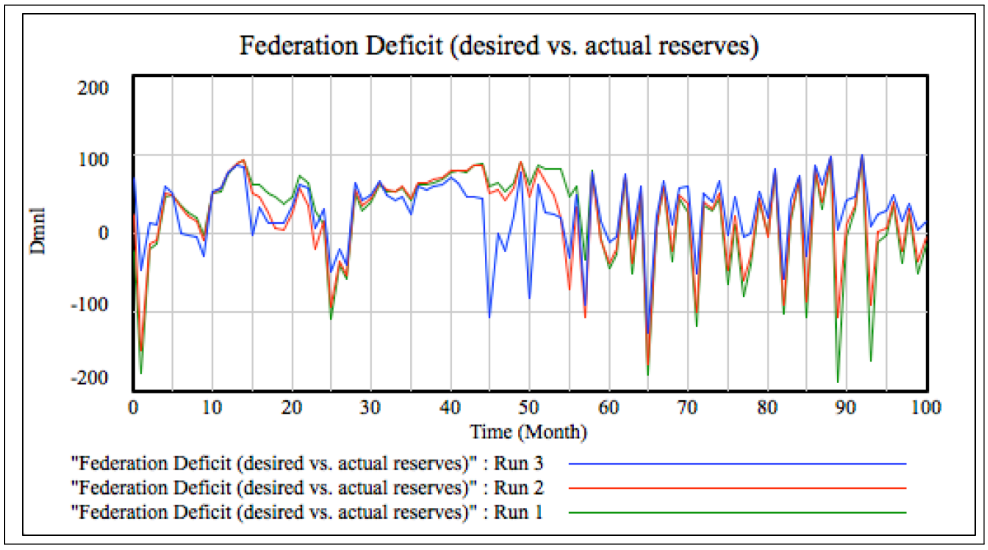

Figure 8.9: Effect of varied funding mixes on federation reserve levels

Effect of increased earmarked funding on balancing mechanism:

Although the increase in earmarked funds has a noticeable effect on funds available for collective allocation as seen in 8.9, this effect seems to dissipate as funds are subsequently allocated to the different programmes. Once earmarked funds are combined with the flexible funds and allocated to a programme, the difference in reserve levels, and ultimately programme performance is reduced. This is particularly evident when considering fund allocation and performance of Programme X as is evident in 8.10.

The first graph in Figure 8.10 shows that the increase in flexible funds has an initial negative effect on the performance of Programme X over the first 24 months. The relative magnitude of the differences between the three runs are also initially not equal - the difference in magnitude between Run 1 and Run 2 is greater than that of Run 2 and Run three in the first graph in Figure 8.10. This is potentially due to the fact that Programme X has a smaller, more volatile programme requirements compared to that of Programme Y and it may be more difficult to "compete" with Programme Y for flexible funds allocation. This, however, dissipates over time, and the changes reach an equilibrium. In this simulation, all other things being equal, the funding mix does not seem to impact programme performance over the long term.

The second graph in Figure 8.10 shows that the different funding mixes also has an effect the performance against strategy with a predominantly flexible funding mix consistently resulting in better performance against strategy. However, the overall behaviour of the performance against strategy variable is the same across all three runs. Further model extensions should consider how an increased number of programmes or incorporating additional influencing variables into performance against strategy would affect this behaviour.

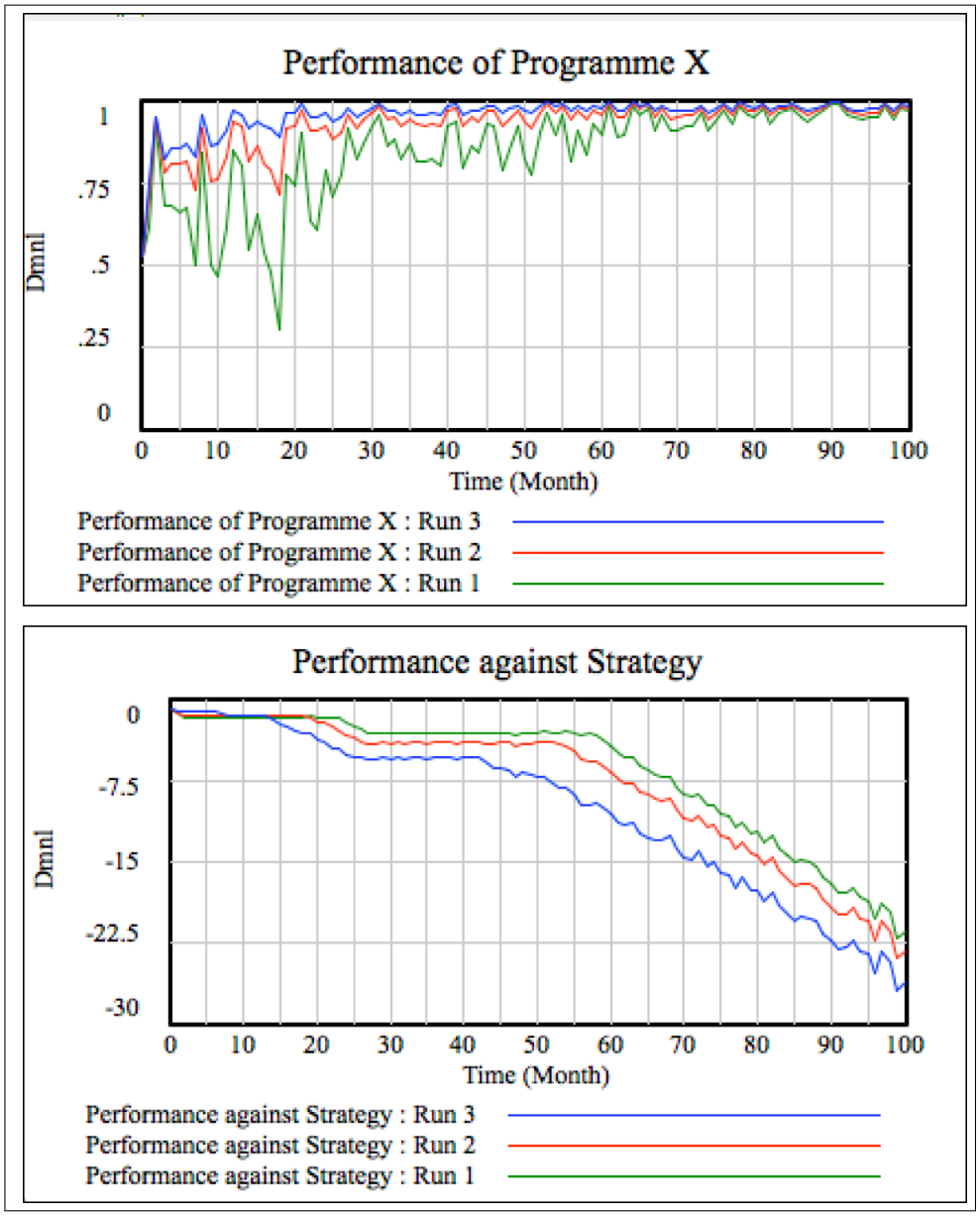

Figure 8.10: Effect of varied funding mixes on programme performance and strategy performance

Effect of variations of the contribution percentage on performance against strategy:

Three different contribution percentages were simulated, these are depicted graphically in Figure 8.11. The first run shows the effect of a low contribution percentage of 20 percent, the second the effect of a medium contribution percentage (50 percent) and the third run shows the effect of a high contribution of 80 percent. These contribution percentages have an expected effect on total funds available for collective allocation, with higher funds available for collective allocation as a result of a higher contribution (Run 3 in blue in Figure 8.11). Again, the predominant behaviour of the overall graph mimics the behaviour of the income generating variables which show the two peaks in the beginning and then smooths out towards the end as seen in the first graph in Figure 8.11. This first graph shows that the relative magnitude of the different runs are exacerbated with higher amounts of funds, as is evident in the "peak" between months 30 and 60. The relative difference in magntitude between Run 1 and Run 2 is lower than between Run 2 and Run 3 during this period. This seems sensible as a higher amount of funds is compounded with a higher contribution percentage resulting an increased total amount of funds for allocation.

The result of the different contribution percentages on *performance against strategy* is slightly different. The different contribution percentages have no effect on the performance against strategy for the first 22 months, after which the lowest contribution percentage reduces performance from month 22 until month 55, as is evident in the second graph in Figure 8.11. This behaviour changes as month 60 when the income reduces which results in a constant decline of performance against strategy. The higher contribution percentage (Run 3 in blue) does allow for a "grace period", buffering the effect of declining income on performance against strategy by 5 months and 15 months compared to a medium (Run 2 in red) and low (Run 1 in green) contribution percentage respectively. This is important for NGO management as it allows for changes to be made in fundraising strategies if income declines in a specific market, however the time lags (between 5 and 15 months) are fairly short to invest in new markets, or other income generating strategies and "early warning" mechanisms should be put in place to ensure minimal impact on performance against strategy.

Reflection on Scenario 2:

The *type* of funds raised by INGOs is *as* important as the size of funds raised as it is closely linked with an INGO's approach to programming. An over-reliance on earmarked funds may result in undue influence over an INGO's resource allocation decisions and undermine an INGOs ability to respond to its primary constituents. In terms of the INGOs engaged in this study, generally flexible funds are preferred over earmarked funds for this very reason.

This scenario tested the effect of progressively increasing the percentage of flexible funds and, although this did result in additional funds available for collective allocation, the effect on long term reserves needs to be further interrogated to ensure that it does not negatively affect the long term sustainability of the organisation. This is an important consideration for INGO management as competition for donors is a daily reality both between INGOs themselves and with other development actors such as social movements or "pop-up" organisations that raise funds for a specific cause and then may dis-ban [Swindoll, 2015]. This, coupled with new profiles of individual supporters (who generally donate flexible funds) plus technology means that flexible funds can be generated at a click of a button as opposed to fundraisers going door-to-door. This type of fundraising may lend itself to emergency/reactive fundraising for

a specific cause, augmenting core funding that allows an organisation to quickly respond to changes in contexts. However, there may not be the same sense of longevity of such supporters and flexible donations which is an important factor for long term sustainability.

When considering performance against strategy in this scenario, the behaviour of this variable remains largely at the mercy of the income generating variables with only minor changes in magnitude when the funding mix and contribution percentages were varied (Figures 8.10 and 8.11). Although the performance variable in this simplified model has a delayed effect on the magnitude of funds raised, it does not influence the *type* of funds raised which could explain the lack of responsiveness across the different runs in this scenario.

Exploring feedback loops in relation to supporter engagement, public perceptions of INGOs and the political climate that influences the boundaries of earmarked funding would likely add more richness to this scenario.

Further model extensions should consider the incorporation of influences such as public perception on the ability to raise flexible funds or the impact of federation reserves on strategy to further test the extent to which these can be levers of change for INGO management.

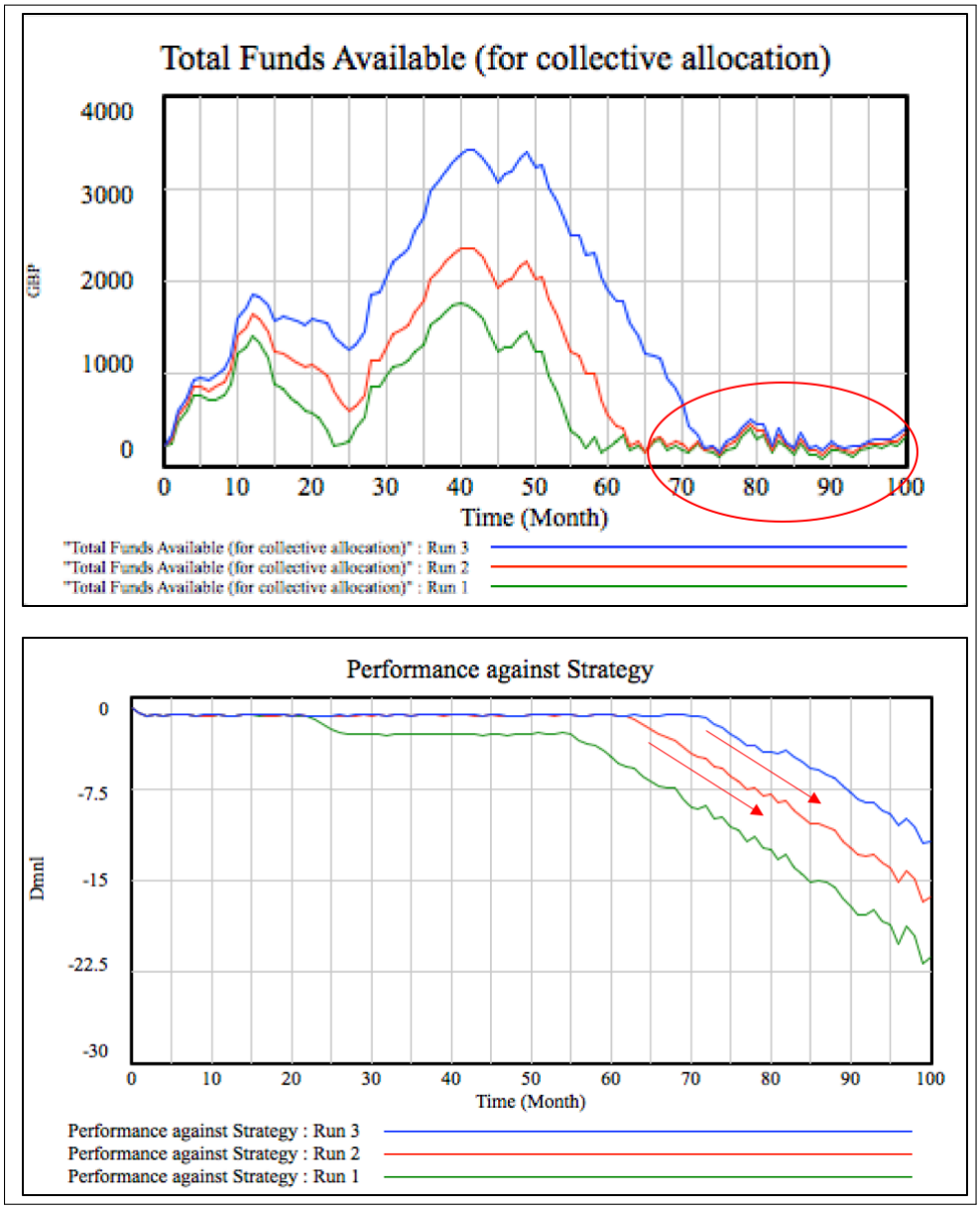

Figure 8.11: Effect of varied contribution percentage on performance against strategy

8.5 Scenario Three

The final scenario that is explored is this study considers the *balancing mechanism* in this allocation model. Based on stakeholder feedback, a resource allocation mechanism in an international NGO should enable the organisation to be financially sustainable and to enable equitable distribution of income based on mutually agreed policies and criteria. This is important to ensure that funds are not saturated in a few country offices, and that all country offices can meaningfully contribute to the organisation. As such, this scenario will look at two aspects of financial sustainability within the resource allocation model.

The first aspect that is considered, is that of including an additional variable to which funds are allocated for *fundraising investment*. These flexible funds are initially kept aside for fundraising investment and are not allocated to Programme *X* nor Programme *Y*. These funds are used to increase the organisation's propensity to fundraise in the future. The simulations will look at the behaviour of the programme performance and performance against strategy over time to see what effect this additional variable will have on the model.

The second aspect that will be considered in this scenario will be the variation of the desired reserves levels. Some international NGOs have a set number of months of income that need to be kept in reserve in case of unexpected events. Considering the fact that the resource allocation model is still largely responsive to the behaviour of the income generating variables, to what extent can an increased reserve level increase the ability for the model to be robust against external shocks? And what is the effect on current, short term performance against strategy. These two sets of simulations and their results are explored below.

8.5.1 Model amendments

Based on the above, specific amendments which have been incorporated into the generic model are described in Table 8.4.

This scenario aims to explore the effect of including an investment variable on performance against strategy and the effect of increasing the desired reserves levels on the overall financial sustainability of the model.

Variable Name	**Amendment**	**Explanation**
Federation investments	Include a third variable for federation fundraising investment with an incremental allocation to the investment fund of 20 percent, 40 percent, 60 percent and 80 percent in Runs 1 through 4	Exploring the effect of investments on project performance vs. performance against strategy over time
Desired reserves levels at a federation level	Varying the desired reserves levels from the initial 2 months (Run 1) to 4 months (Run 2) and then down to 2 weeks (Run 3)	Exploring the effect of set reserves level based on policy versus a risk-related reserve level on performance against strategy

Table 8.4: Model amendments for financial sustainability

Again, it is important to note that the degree to which variables are increased or decreased are set fairly arbitrarily. It is the model behaviour that is of most interest and not the specific values of constants as this is a hypothetical model.

8.5.2 Simulation Results

Effect of additional investment variable on funds available for allocation and programme performance

The addition of an investment variable which diverts funds away from immediate allocation towards investment in generating income in emerging markets, does show a relative increase in the long run. Runs 1 to 4 show a progressive increase in the percentage of funds that is diverted to emerging markets. Run 1 in grey has the smallest allocation to investment, 20 percent, whilst Run 4 in blue has the largest allocation, 80 percentage, for investment.

The graph in figure 8.12 shows that investments need to be fairly substantial to have an impact on the total funds available for allocation as is evident by Run 4 in blue which shows the highest percentage allocated to investments. Runs 1 to 3 have the same relative magintude until month 70 when Run 3 shows an increase. However, Run 4 shows an increased magnitute from the beginning with an increased effect after month 70. This may be as a result of the fact that in this model, less funds are raised in emerging markets and therefore more of an emphasis needs to be placed on fundraising diversification.

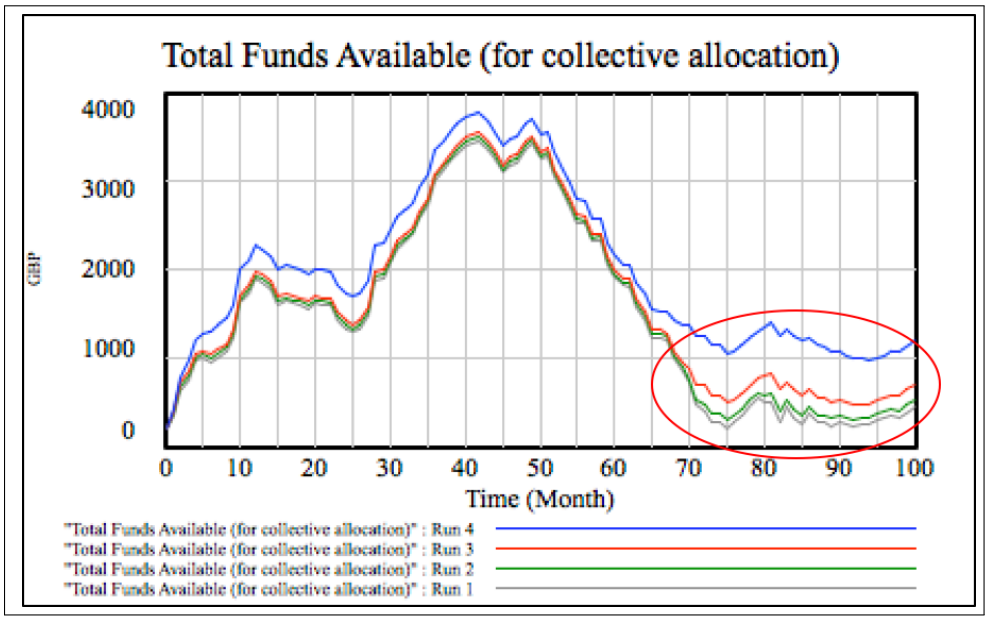

Figure 8.12: Effect of investments on funds available for allocation

The resulting effect on the programme performance varies. The first graph in Figure 8.13 shows the resulting effect on Programme X. Because there are less funds available for allocation in the short and medium term, the relative allocation to Programme X is higher and this eventually evens out over the longer term.

However, this is not the case for Programme Y as is evident in the second graph in Figure 8.13. Since Programme Y is the larger programme, it mostly relies on earmarked and flexible funds from mature markets. Because the programme requirements are large in the shorter term a substantial investment would negatively affect this programme.

In both these cases though, a significant investment percentage of more than 60 percent is required for any substantial change in behaviour of programme performance as is evident in the behaviours of Run 4 (in blue).

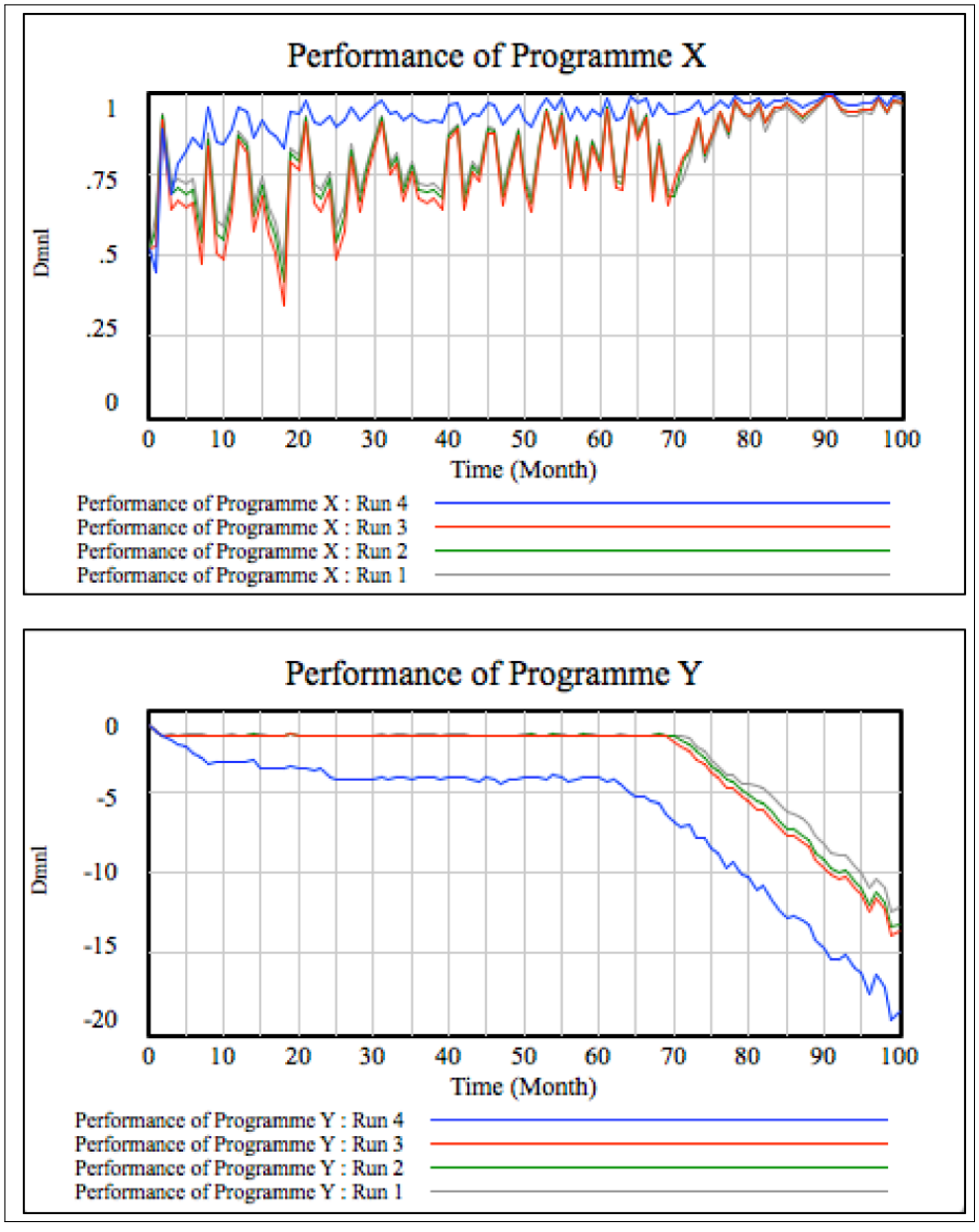

Figure 8.13: Effect of investments on programme performance

Effect of higher reserve requirements

The variations in reserve requirements have different effects when considering the federation vis-à-vis programmatic levels as is evident in Figure 8.14. Three simulation runs were conducted with Run 1 maintaining the desired reserves level of 2 months. Run 2 shows an increased reserve level of 4 months whilst Run three has a reduced reserve level of 0.5 months. The effect of the variations in desired reserves level does have an impact on the federation deficit. As is to be expected, with a higher reserve level of 4 months (Run 2), which is double the desired reserve level of the generic model, the magnitude of the federation deficit increases and this increase is exacerbated when there is a low overall income. This can be seen in Figure 8.14 between months 70 and 100, where the lower total income (in the top graph of Figure 8.14) coincides with erratic deficits, especially for Run 2 with the additional 2 months requirement.

When considering Run 3, with a lower reserves requirement of 2 weeks, a quarter of the desired reserves requirements in the generic model, the behaviour of the federation deficit is somewhat smoothed, as is evident in the blue line in the bottom graph in Figure 8.14. There is remains some volatility during months 70 to 100 when the total income is low, however it is attenuated.

It is important to note that, the second graph focuses on the deficit and any surplus funds (beyond 2 months, 4 months and 2 weeks in Runs 1 to 3 respectively) are automatically directed for reallocation so that there is not a build of funds in reserves. This is reflected in the bottom graph in Figure 8.14 where the variations in magnitude are only towards the negative and are do not fluctuate upwards beyond the respective upper bounds.

When comparing the federation deficit behaviour to the relative allocation to programmes in the first graph in Figure 8.14, it is evident that the variations in reserve levels do not affect the primary behaviour of total funds available for allocation. Although the federation deficit is used to determine the amount of funds available for collective allocations to programme, the influence is minimal compared to the predominant influence of the income generating variables.

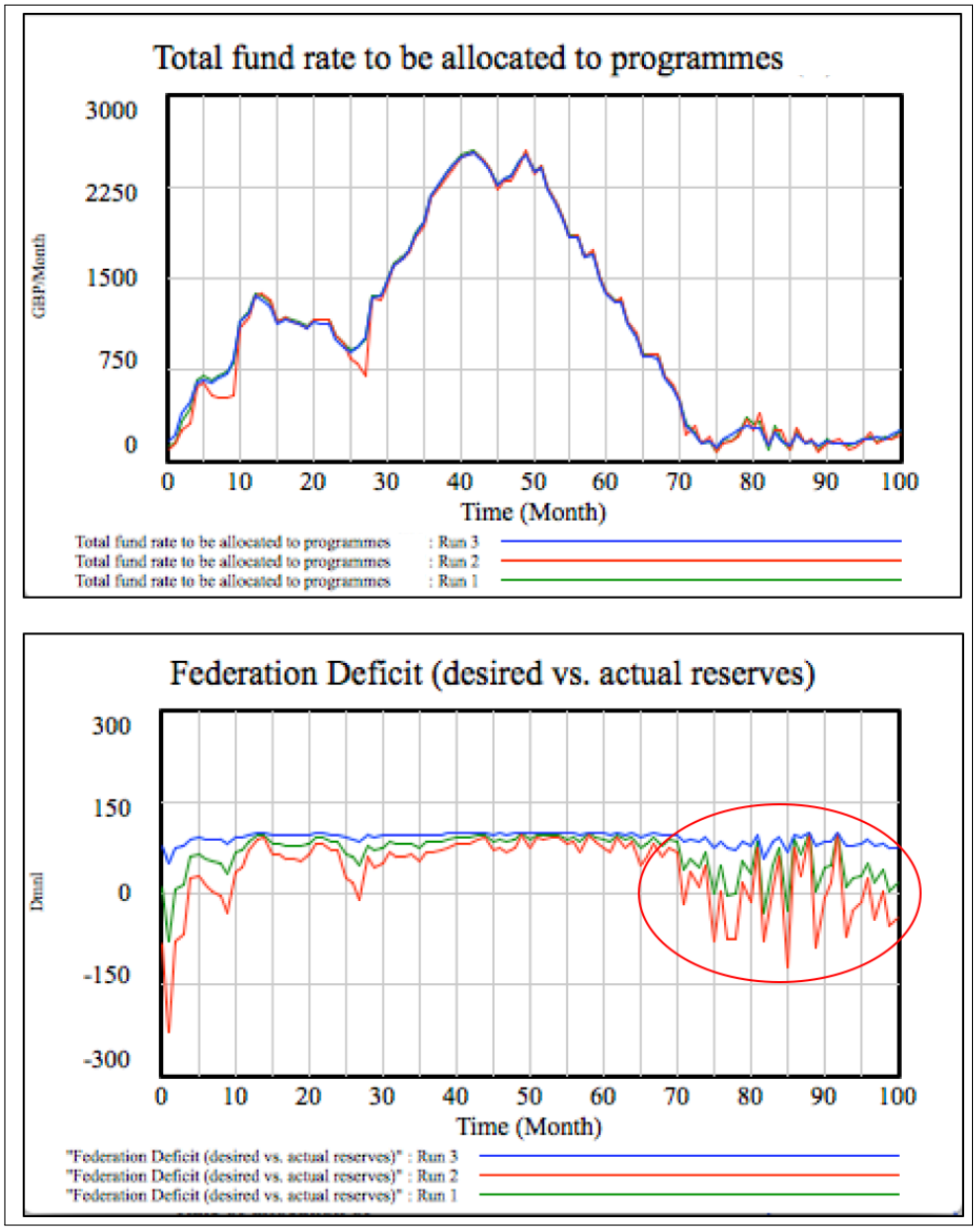

Figure 8.14: Effect of variation in reserve requirements on total funds available and deficit levels

Reflection on Scenario 3:

Decisions pertaining to financial investments for INGOs, whether its in new fundraising markets, new technologies or infrastructure, are generally approached with caution. Earmarked funds, either wholly or partially, are often restricted to pay for direct and/or indirect programme costs which often exclude fundraising investments or operational efficiency (e.g. new IT software) related expenditure. This means that INGOs that want to invest in different funding markets, innovative approaches or technologies generally need to rely on flexible funds to do so. Therefore management decisions aimed at reducing reserves or diverting flexible funds

away from immediate programme requirements for investment in future returns, need to be thoughtful and supported by rigorous analysis to minimise impact on financial sustainability and the ability of the INGO to meet current programme requirements.

In both instances in this third scenario, the incorporation of an investment variable and the variation of desired reserve levels requires a significant increase or presence (more than a 60 percent deviation from the generic model) in order to affect the overall behaviour of resource allocation at a programmatic level and changes to performance against strategy. This is an important insight from an INGO management perspective because it demonstrates the significant time and effort required to diversify income through investment in new markets. Not only does it take some time for the returns on such investments to have an effect on the overall resource allocation framework, it also shows that consolidating investment efforts, i.e. a focusing on a more sizeable investment in fewer markets, may provide a better opportunity to influence funding mixes and resource allocation policies.

Changing the desired reserves levels variables had minimal impact on the overall behaviour of total funds available within the overall model as it is still primarily driven by the income generating variables. With a reserves requirement of 2 weeks, the federation deficit is reduced and smoothed whilst with a reserve requirements of 4 months, the magnitudes of the deficits are reinforced, especially when income levels of low. INGO management should discuss the pros and cons of the size of reserves being held at federation versus programme level in order to maximise responsiveness whilst protecting themselves against volatile and/or decreasing income levels.

In this scenario, Programmes X and Y also respond differently to the changes in investment and reserve levels. As was described in Chapter 6, the characteristics of Programme X are that of a smaller more volatile programme that struggles to draw in flexible funds away from Programme Y to meet its requirements due to lower programme requirements and higher volatility. On the other hand, Programme Y is a larger, more stable programme whose requirements are largely met by earmarked funds and, because of its higher requirements, draws additional flexible funds away from Programme X due to the way that the balancing mechanism is structured in this resource allocation model. The progressive increase in investment percentages, depicted in Figure 8.13, is more detrimental to Programme Y which relies on large amounts of flexible funds to meet its programme requirements.

Future studies could consider how to incorporate additional influences for the desired reserves level, such as programme risk, as this may have different effects on the model.

8.6 Summary

In this chapter three management scenarios were simulated, applying various model amendments to the generic model described in Chapter 6. The management scenarios included variations in income generation, adjustments to contribution percentages, variations in funding mixes and testing financial sustainability through the variation of desired reserves and investment variables.

The amendments applied and the model results for each of these were discussed in detail as well as their implications from an NGO management perspective. In the next chapter, these results more holistically in relation to the resource allocation model's success criteria that were identified through stakeholder engagement and described in Chapter 6.

Chapter 9

Implication of Results

In the previous chapter, the different management scenarios and their individual results were explored in detail. In this chapter, these results will be analysed and discussed in relation to the model's success factors that were identified in Chapter 6. Reflections on these results are discussed as well as the implications and key messages for management in the INGO sector.

As mentioned previously, these results are illustrative of the power of applying system dynamics modelling to resource allocation mechanisms in INGOs and the discussion below provides examples of how these types of results could be interpreted in the INGO management context.

9.1 Discussion of scenario results

At the end of Chapter 6, three measures of success for this system dynamics model were identified based on stakeholder feedback. These measures provide different lenses through which to evaluate the model. The results of the scenarios and simulations are discussed in relation to these measures of success below as well as drawing attention to some general insights.

Performance against strategy:

The model was able to explore which variables would be most affected by an *increased volatility* in the income generating variables. The behaviour of performance against strategy is strongly correlated with the behaviour of the income generating variables, especially that of income being generated in mature markets. This behaviour is inherent in the system due to the over-reliance on income generated in mature markets. Although in real-life situations performance against strategy will be influenced by a number of other external uncertainties, the ability to raise funds to meet programme requirements and having an organisation that is robust enough to withstand sudden changes in the funding landscape, is well understood in the sector.

Diversifying income and including additional markets with their different behaviours would lessen the overall strategy performance on one specific market. Although market volatility is not a lever of change from a management perspective, mitigating the effect of its volatility should be a priority for any resource allocation mechanism. This is in line with the initial stakeholder feedback, and this model's results could support an income diversification strategy

and increase buy-in from INGO decision makers. System dynamics could also provide some interesting insights when considering how to diversify and help decision makers model the longer term effects of such decisions on the sustainability of the organisation and its ability to effectively deliver its programmes.

Although external uncertainties are not in the control of INGO decision makers, the parameters involved in what to do with the funds once raised (especially flexible funds) are critical levers of changes in resource allocation. The *contribution percentage*, is one such lever, determining the minimum amount of funds that should be made available for collective allocation. In this model, the contribution percentage has a delayed effect on performance against strategy. It is a non-linear effect, with increased contribution percentages having an increased negative effect on performance against strategy in the long term. This shows the necessity of having an affordable contribution percentage that also allows existing fundraising countries to invest in their own markets. This is just as important as having funds available to diversify into new markets. Even although contribution percentages in this model were set fairly arbitrarily and were independent variables, this is illustrative of a type of model structure that can be further investigated, to assist INGO managers to gain a deeper understanding of the longer term effects of their fundraising strategies.

It is also worth noting that the behaviour of the various fundraising variables changed over time and therefore related strategies and parameters should be periodically reviewed and adjusted, based on income trends and programme requirements to ensure that the percentage that is applied is appropriate and delivers required results.

Financial sustainability:

From a financial sustainability perspective, there was a long term positive effect when the *investment variable* was incorporated into the model. The short term effect of fundraising investment resulted in reduced allocation to programmes but the magnitude was minimal and was largely mitigated by the federation allocation level variable and federation reserve levels.

Although this is a general result, this does not necessarily validate the inclusion of such an investment variable. Rather, it indicates that an appropriate investment function, contextualised for a specific INGO, within the resource allocation model should be considered in order to explore its long-term financial sustainability.

Further analysis of different programme funding combinations could uncover the more subtle diversions of flexible funds however this was not explored in the simulation and could be considered in future studies. The affordability of such an investment variable will depend upon the relative size of flexible funds. There would be a trade-off between having funds available in the moment for immediate programming compared with the "opportunity cost" of saving for the future. Additional variables monitoring the potential negative effect of a reduction in immediate funds and the affect on the INGO's brand, fundraising capacity and/or "faith" in the institution need to be considered in relation investment opportunities as well as size and timing of the returns.

Changes to the *desired reserves levels* at a federation level do not impact the financial sustainability of this model. Based on the various model simulations, this could mean that the reserves policy is not an influential lever of change. It is important to note that desired reserves

level in this simplified model was included a independent variable with no other variables influencing it. This is most likely not the case in "real-life" INGO management contexts as reserve levels are also influenced, for example, by volatility within programme countries which was not featured in this model. Rather, reserve levels, in this case, are illustrative of a type of structure that should be further investigated and expanded upon, based on different organisational and external contexts, focussing on the influences and implications of different reserve policies and its effect on financial sustainability.

Predictability of income for programmes:

The ability for any resource allocation mechanism to provide predictability in terms of income for programmes is crucial. This model attempts to do this through the creation of a balancing mechanism that uses the flexible funds allocation to offset programme deficits in relation to earmarked funds.

The resulting behaviour of the balancing mechanism in this model illustrates the benefit of considering the *combined* effect of these two types of funds. The generic model and the simulations show how this mechanism "protects" overall programme performance by ensuring that individual programme deficits do not become too burdensome with the allocation of flexible funds.

It is important to note that the balancing mechanism in this model is an example of a simple structure that can integrate these two types of funding into one framework. The application of such a mechanism in the context of decentralised INGOs is much more complex as these organisations deal with hundreds of programmes with different types of requirements and their differentiation between earmarked vs. flexible funds is not straightforward nor broadly applicable across all programmes. It is unlikely that any model will provide a silver bullet to solve such management dilemmas which need to take into account very many quantitative components overlaid with underlying power dynamics and conflicting objectives when it comes to, often highly contested, resource allocation strategies. However, as system dynamics is an iterative process, steps can be taken to consider piloting the integration of earmarked and flexible funds into one allocation mechanism in certain areas and to learn and expand from there.

Not only does this simple model depict the benefit of this type of a balancing mechanism, it is also in line with the initial stakeholder feedback which articulates the importance of a resource allocation mechanism to minimise negative impact on programme and mission related activities. This would ultimately contribute to the predictability of programme income as any sudden change in earmarked funds are offset with flexible funds, providing decision makers a "grace" period to adjust and adapt the programme as required.

9.2 Considerations for INGO management

The scenarios in Chapter 8 and the points mentioned earlier in this chapter are illustrative of how management can reflect on such a system dynamics modelling exercise to gain insights into the effects of different parameters on a resource allocation model. These should be further interrogated to deepen the understanding of such a model in different management contexts in order to inform any future policy development in this area.

This process allows for management to input different policy parameters to see how these would affect the model and to simulate different challenging situations in order to test potential solutions. This can also lead into more specific applications of resource allocation models which would result in more specific conclusions based on individual organisational contexts. These areas of future exploration are presented in the final Chapter.

The use of system dynamics to develop the simplified model is this study provides a starting point for a more robust conversation about the relevance and power of such an approach in the INGO management space. The system dynamics approach provides a transparent and reliable process which can used to enhance stakeholder buy-in through model development and analysis. It also increases the likelihood of the model's results to be interpreted into actionable recommendations and implemented within an organisation.

It is important to distinguish the difference between policy levers and external factors beyond management control. For example, this process is not trying to understand and predict the uncertainty of volatile markets or the changes in requirements, however incorporating even some simple variables to introduce random uncertainty will provide much more insight into how levers of change respond in such externalities.

The model and the three management scenarios discussed in Chapter 8 are only the tip of the iceberg, so to speak. Each of the above scenarios can and should be further explored to address specificities in the different management contexts. For example, diversification of fundraising, and the different funding mixes can be dissected and modelled individually in more detail.

It is important to reiterate that the process followed in this study is not about creating an optimal solution, rather, an illustration of how such a process could prove useful for strategic planning and long term financial planning that usually takes place in an international NGO every 5-8 years. The use of scenarios could be particularly beneficial in understanding the effect of different strategic decisions on specific management processes, systems or structures.

Unfortunately, the stakeholders that were interviewed when this study was initiated were no longer available for engagement and formal feedback on the results and findings. However, should the opportunity have presented itself, the following four messages would have been shared for discussion and reflection:

1. **System dynamics can be a useful tool for international NGO management processes.** It has the ability to take into consideration many diverse views, provide insights into the interactions and long term effects of policy decisions and its robustness can increase confidence in decision making processes.
2. **System dynamics modelling, applied resource allocation processes, has the ability to develop quantitative and qualitative recommendations.** The focus

of this study has been on qualitative management decisions, considering the overall behaviour of the model, in relation to, for example balancing funds between different programmes. However, this generic model can be extended and adapted to represent a specific "real life" allocation situation, upon which specific financial parameters can be determined to optimise allocation.

3. **This study revealed key policy levers that have an effect on resource allocation.** Policy parameters such as contribution percentages or different funding combinations of flexible funds versus earmarked funds, when modelled in more detail, can be used to inform fundraising and income diversification strategies.

4. **The importance of modelling external influences.** External factors such as programme requirements and market volatility have significant influence over resource allocation. The ability to bring these influences into a management model will allow for a more informed strategy, both from a fundraising perspective as well as a programmes perspective.

The next chapter continues to discuss the above in terms of recommendations for future studies and the limitations within this study.

Chapter 10

Conclusion and Recommendations

10.1 Conclusions

The development issues plaguing the global community are increasingly complex and interlinked, not always adhering to geographical boundaries. Single-issue solutions are no longer appropriate in our context. For example, fighting climate change takes combined economic, political and environmental action. Although some of these issues do not discriminate, those that are most deeply affected are people living in poverty, caught in a perpetual cycle that requires a systemic change.

International NGOs have always played an important role in development. These organisations are well positioned to be a catalyst for structural change, working with local communities, governments, donors and private sector to achieve transformational change. However, the management structures of such organisations are still evolving in order to better deal with today's complexity to effectively eradicate poverty, societal injustice and climate change.

This study is a good example of how a system dynamics modelling approach can help unpack and model certain challenges that international NGOs face, in order to better deliver their respective missions. This study focusses on one such management challenge, that of resource allocation, the raising and distribution of funds. This particular management process was chosen based on the author's management experience in an international NGO - the inspiration for this study.

A brief background to this study was provided in Chapter 2, including an introduction to Non Government Organisations (NGOs) and the development context in the 21st century. ActionAid International and Greenpeace International were introduced as two examples of NGOs that have adopted decentralised structures, the NGO profile that is of interest in this study.

In Chapter 3, the focus of the study was further refined, justifying the choice of resource allocation as a relevant management process with "real world" challenges that can benefit from a system dynamics approach. Chapter 4 included a literature review, which emphasised the application of system dynamics in similar contexts and the potential complementarity of operations research techniques in the modelling process.

In Chapter 5, the stakeholder engagement process was explained and the resulting management descriptions of resource allocation were summarised based on their feedback. This stakeholder engagement process was a core component of the study as it identified a handful of "real world" challenges in relation to resource allocation which formed the basis of the modelling process. As identified in the literature review, operational research problem structuring methods were applied to the management descriptions in order to define a more structured problem which was then transformed into a system dynamics model. The problem structuring methods that were used were soft systems methods and strategic options decision analysis, as these were deemed the most appropriate given the level of stakeholder engagement and type of information that was gathered. The resulting rich pictures, root definitions and cognitive maps were used to inform the system dynamics modelling process.

Chapter 6 introduced system dynamics as the overall modelling approach and described in detail the resource allocation model that was developed using Vensim PLE modelling software. The model that was developed was not meant to be a full representative of resource allocation in an international NGO. Rather the model attempted to take into account core common components and provide a framework that could demonstrate how such a model could be useful and provide insights for management decision making. The model was simplified to include two types of income generating entities with two types of funds, earmarked and flexible, which could be pooled and distributed to two programmes. One specific feature was the inclusion of a balancing mechanism. This mechanism takes into account the extent to which earmarked funds satisfied programme requirements and allocated flexible funds in response to this. In reality, this is much more complex with many more entities raising funds and tens of hundreds of programmes receiving funds. However as this is an initial exploration of this type of analysis, the simplified model was deemed sufficient for the purposes of this study. The model's assumptions, structure and behaviour were validated in Chapter 7 after which a set of management scenarios were simulated.

Chapter 8 describes the management scenarios that were simulated and the impact of these different scenarios on the performance of the model. Three management scenarios were individually overlaid on the generic model developed in Chapter 6. These scenarios explored the extent to which the model was robust against external volatility, the effect of different funding mixes on the model's balancing mechanism and the effect of investment of performance against strategy. The results were discussed and key insights summarised in Chapter 9. These simulations revealed key levers for change for management. These levers included the contribution percentages, the importance of diversification of income sources as well as the funding mix of an organisation and the potential benefits of a balancing mechanism between different types of funds. In addition, the model highlighted the influence of income generating countries over the behaviour of the model. This further substantiates the importance of fundraising diversity.

Unfortunately, due to insufficient time and access to stakeholders towards the end of the study, these results were not shared with stakeholders. However, from a research perspective, this study can be used to introduce the concept and benefits of the system dynamics modelling approach that takes into account feedback loops and multiple perspectives. It can help take the "politicking" out of contentious decisions, such as resource allocation, and can help with stakeholder buy in for different management strategies due to its robustness.

10.2 Limitations of the study

There were two core limitations to this study:

1. **Limited scope of study:** The scope of this study was focussed on one aspect of resource allocation within international NGOs with one specific organisational profile. This meant that the generic model would need further extension it it were adopted by any one organisation.

2. **Limited access to stakeholders:** Engagement with stakeholders waned towards the end of the study. This meant that the research outcomes were not shared with stakeholders and no direct action will be taken from a management perspective.

Effect of the limitations on the system dynamics model:

The system dynamics model is a fairly simple representation of a generic resource allocation mechanism. Additional modelling would need to take place to solve specific problems and identify optimal parameters. The management scenarios are simple amendments to the model, more for illustrative purposes than for any other reason. This model is useful to show the benefits of the application of such a modelling approach, however, a more in-depth model would be needed for actual management decision making for a particular organisation.

Effect on the limitations model's direct application:

The limited stakeholder engagement, in particular access to INGO management decision makers, means that it is unlikely that any specific actions in relation to resource allocation will be taken. This study provides a glimpse of the power of system dynamics modelling, even with this simple model. However, additional awareness and deeper understanding of system dynamics would be required for NGO management to adopt such an approach. Investment in a full system dynamics project may require additional resources and funds, which may not be a management priority. However, as complexity is inherent in development issues this may provide an incentive for NGOs to explore such approaches. This study could therefore prove to be a useful reference point should any further projects be undertaken.

Finally, system dynamics modelling may be viewed as a complicated tool by management teams. The concept and approach should be thoughtfully introduced to gain buy in so that the specificity and precision it requires is acknowledged and understood to avoid potential project abandonment.

10.3 Recommendations for future research

There is definitely scope for further exploration in the area of system dynamics and its application to NGO management challenges. A major outcome of this study was to prove the applicability and benefits of such a modelling technique in this area. It is hoped that this will stimulate interest and engagement from NGO management to practically employ such approaches when dealing with complex systems and processes to improve outcomes and impact.

What follows is a summary of suggestions for future research, some of which are particular to the extension of this study whilst others may have a wider application.

- Explore other resource allocation related challenges that stakeholders presented in their initial engagement:
  - Model the conflicting objectives *between* offices in a federal structure as well as *within* offices to explore the impact of "dual citizenship" (national versus international agendas) and the impact on resource allocation
  - The combination of earmarked income and flexible income into one model, as was the case in this study, may add additional process complexity, consider the effect of this integration on time and resources
  - Although potentially sensitive, it would be very interesting to model the hidden power dynamics in an international NGO with a federal structure and see how these dynamics influence decision making processes, especially in relation to resource allocation
- Further application of "soft" OR techniques in the international NGO management setting:
  - The incorporation of problem structuring methods in strategic change management processes could prove beneficial, especially decision conferencing and scenario planning
  - Cognitive maps (SODA analysis) could have multiple applications, especially during exhaustive consultative processes where transparency is of the utmost importance in terms of *how* decisions get made
- Extension of the system dynamics resource allocation model itself:
  - Expand the number of fundraising and programme entities by incorporating additional level variables
  - Consider the implication of programme entities also raising funds (i.e. not just fundraising countries) and how this would impact the balancing mechanism. Should these funds be used for individual country financial sustainability or pooled and allocated by the federation?
  - Incorporate additional influencing variables for the programme against strategy variable
  - Explore a different variable for reserves based on risk (both fundraising and programme risk)
- Additional management scenarios to consider:
  - Consider combining the management scenarios in this study to understand their combined effect on resource allocation
  - Consider a scenario which alters the decision rules in terms of allocation of funds, beyond relative programme deficits, may include an override for "priority funds"

  - Check to see the extent to which additional diversification has an effect on the behaviour of allocation and performance against strategy

- Stakeholder re-engagement:
  - Using this study as a reference, engage with INGO management stakeholders to see their reaction to such a model
  - Attempt to raise funds from donors to do a more specific system dynamics project within an INGO
  - Look at other challenges in the INGO management space where soft OR and system dynamics may help in terms of project prioritisation, strategic planning and modelling the effect of specific advocacy vs. service delivery to see which is more effective
  - Consider how such a model can be set up so that management can simulate different scenarios for their own organisations

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Appendix - Vensim Model Variables

Ref No.	Variable Name	Variable Type	Algebraic Equation	Unit	Causes (other variables that influence this variable)	Uses (other variables that are influenced by this variable)	Description
1	MuH	Constant	500	GBP/month	None	Rate Changes	Upper limit for the random uniform function that determines the rate changes for income in mature markets
2	MuL	Constant	100	GBP/month	None	Rate Changes	Lower limit for the random uniform equation that determines the rate changes for income in mature markets
3	Rate Changes	Auxiliary	IF THEN ELSE(MODULO(Time, 12) = 0, (RANDOM UNIFORM (MuL, MuH, 0) - IncomeRateLevel MM) / TIME STEP, 0)	GBP/(Month*Month)	MuH, MuL, Time Step and Time	Income Rate Level MM	The random uniform function with a step change every 12 months which generates the mean of the income rate in mature markets
4	Income Rate Level MM	Level	Rate Changes *(with an initial value of 200)*	GBP/month	Rate Changes	RateChanges, Random Normal Income Rate MM	As above
5	Random Normal Income Rate MM	Auxiliary	RANDOM NORMAL (lower limit = 0, upper limit = 10000, mean = IncomeRateLevel MM, sigma = 10, 1)	GBP/month	Income Rate Level MM	Total Federation Income - Mature Markets	The random normal function that generates income rates in mature markets
6	Total Federation Income - Mature Markets	Auxiliary	Random Normal Income Rate MM * Effect of Performance of Strategy on Total Income	GBP/month	Random Normal Income Rate MM, Effect of Performance of Strategy on Total Income	Earmarked funds, Funds Available for Global Allocation - Mature Markets	The random normal income rate for mature markets multiplied by the delayed effect of performance against strategy
7	MuH 0	Constant	100	GBP/month	None	Rate Changes 0	Upper limit for the random uniform function that determines the rate changes for income in emerging markets
8	MuL 0	Constant	50	GBP/month	None	Rate Changes 0	Lower limit for the random uniform equation that determines the rate changes for income in emerging markets
9	Rate Changes 0	Auxiliary	IF THEN ELSE (MODULO (Time, 12) =0, (RANDOM UNIFORM (MuL 0, MuH 0, 0) - IncomeRateLevel EM) / TIME STEP, 0)	GBP/(Month*Month)	MuH 0, MuL 0, Time Step and Time	Income Rate Level EM	The random uniform function with a step change every 12 months which generates the mean of the income rate in emerging markets
10	Income Rate Level EM	Level	Rate Changes 0 *(with an initial value of 100)*	GBP/month	Rate Changes 0	RateChanges 0, Random Normal Income Rate EM	As above
11	Random Normal Income Rate EM	Auxiliary	RANDOM NORMAL (lower limit = 0, upper limit = 10000, mean = IncomeRateLevel MM, sigma = 50, 1)	GBP/month	Income Rate Level EM	Total Federation Income - Emerging Markets	The random normal function that generates income rates in emerging markets
12	Total Federation Income - Emerging Markets	Auxiliary	Random Normal Income Rate EM * Effect of Performance of Strategy on Total Income	GBP/month	Random Normal Income Rate MM, Effect of Performance of Strategy on Total Income	Earmarked funds, Funds Available for Global Allocation - Mature Markets	The random normal income rate for emerging markets multiplied by the delayed effect of performance against strategy
13	Proportional Splits - Flexible Funds	Constant	0.6	Dimensionless	None	Earmarked funds, Funds available for Global Allocation - Mature Markets	The percentage that determines the amount of funds available for collective allocation
14	Proportional Splits - Earmarked Funds	Constant	0.7	Dimensionless	None	Funds Earmarked for Programme Y, Funds Earmarked for Programme X	The percentage that determines the amount of funds that have been earmarked
15	Funds available for Global Allocation - Mature Markets	Auxiliary	Total Federation Income Mature Markets * Proportional Splits Flexible Funds	GBP/month	Proportional Splits - Flexible Funds, Total Federation Income - Mature Markets	Desired Reserves for Programme Allocation , Inflows	Percentage of funds available for collective allocation from mature markets

Ref No.	Variable Name	Variable Type	Algebraic Equation	Unit	Causes (other variables that influence this variable)	Uses (other variables that are influenced by this variable)	Description
16	Earmarked Funds	Auxiliary	Total Federation Income Mature Markets * (1 - Proportional Splits for Flexible Funds)	GBP/month	Proportional Splits - Flexible Funds, Total Federation Income - Mature Markets	Funds Earmarked for Programme Y, Funds Earmarked for Programme X	Percentage of funds available earmarked from mature markets
17	Funds Earmarked for Programme Y	Auxiliary	Earmarked Funds * Proportional Splits Earmarked Funds	GBP/month	Earmarked Funds, Proportional Splits Earmarked Funds	Rate of Allocation of Earmarked Funds - Programme Y	Percentage of funds available earmarked for Programme Y
18	Funds Earmarked for Programme X	Auxiliary	Earmarked Funds * (1 - Proportional Splits Earmarked Funds)	GBP/month	Earmarked Funds, Proportional Splits Earmarked Funds	Rate of Allocation of Earmarked Funds - Programme X	Percentage of funds available earmarked for Programme X
19	Contribution Percentage - Emerging Markets	Constant	0.3	Dimensionless	None	Funds available for Global Allocation - Emerging Markets	The percentage that determines the amount of funds available for collective allocation from emerging markets
20	Funds available for Global Allocation - Emerging Markets	Auxiliary	Total Federation Income Emerging Markets * Contribution Percentage Emerging Markets	GBP/month	Contribution Percentage Emerging Markets, Total Federation Income - Emerging Markets	Inflows	Percentage of funds available for collective allocation from emerging markets
21	Inflows	Auxiliary	Funds Available for Global Allocation Mature Markets + Funds Available for Global Allocation Emerging Markets	GBP/month	Funds available for Global Allocation - Emerging Markets, Funds available for Global Allocation - Mature Markets	Total Funds Available (for collective allocation)	Sum of funds available for collective allocation from both mature markets and emerging markets
22	Total Funds Available (for collective allocation)	Level	Inflows - Outflows *(with an initial value of 200)*	GBP	Total Funds Available (for collective allocation), Inflows, Outflows	Federation Deficit (desired vs. actual reserves), Total Fund Rate to be Allocated to Programmes, Outflows	The actual amount of GBP available at a point in time for collective allocation
23	Outflows	Auxiliary	Actual Allocation	GBP/month	Total Funds Available (for collective allocation)	Actual Allocation	The monthly amount that is actually allocated between Programme X and Programme Y
24	Actual Allocation	Auxiliary	Rate of Allocation of Collective Funds to Programme X + Rate of Allocation of Collective Funds to Programme Y	GBP/month	Rate of Allocation of Collective Funds to Programme Y, Rate of Allocation of Collective Funds to Programme X	Outflows	The monthly amount that is actually allocated between Programme X and Programme Y
25	No. of Months Required for Reserves	Constant	2	Month	None	Desired Reserves for Programme Allocation	Number of months of required reserves as per policy
26	Desired Reserves for Programme Allocation	Auxiliary	Funds Available for Global Allocation Mature Markets * No. of Months Required for Reserves	GBP	No. of Months Required for Reserves, Funds available for Global Allocation Mature Markets	Federation Deficit (desired vs. actual reserves)	The desired reserves level based on funds available for global allocation of mature markets (as this is the more stable income stream)
27	Federation Deficit (desired vs. actual reserves)	Auxiliary	100 * (Total Funds Available (for collective allocation) - Desired Reserves for Programme Allocation) / Total Funds Available (for collective allocation)	Dimensionless	Desired Reserves for Programme Allocation, Total Funds Available (for collective allocation)	Deficit Multiplier	The extent to which funds available meet desired reserves expressed as a proportion which would indicate either a surplus or a deficit at the federation level
28	Deficit Multiplier	Auxiliary with Look Up	Federation Deficit (desired vs. actual reserves)	Dimensionless	Federation Deficit (desired vs. actual reserves)	Proportion Used per Month	The mapping of the federation deficit onto a look up table to establish the resulting behaviour (the closer the deficit or is to zero the more subtle the effect on the model, and the more extreme the deficit or surplus the behaviour exacerbates)

Ref No.	Variable Name	Variable Type	Algebraic Equation	Unit	Causes (other variables that influence this variable)	Uses (other variables that are influenced by this variable)	Description
29	Standard Proportion	Constant	0.5	1/Month	None	Proportion Used per Month	Standard proportion
30	Proportion Used per Month	Auxiliary	Deficit Multiplier * Standard Proportion	1/Month	Deficit Multiplier, Standard Proportion	Total Fund Rate to be Allocated to Programmes	Determines the monthly proportion of funds that can be used based on the existing federation deficit
31	Total Fund Rate to be Allocated to Programmes	Auxiliary	Proportion Used per Month * Total Funds Available (for collective allocation)	GBP/month	Proportion Used per Month, Total Funds Available (for collective allocation)	Rate of Allocation of Collective Funds to Programme Y, Rate of Allocation of Collective Funds to Programme X, Alpha Max, Alpha Min, Sufficient funds for Allocation to Programme X and Programme Y	Determines the rate of total funds available for collective allocation to either Programme X or Programme Y
32	Rate of Allocation of Collective Funds to Programme Y	Auxiliary	IF THEN ELSE (Sufficient funds for Allocation to Programme X and Programme Y = 1, Programme Y Deficit, Total Fund Rate to be Allocated to Programmes * (1 - Alpha (a)))	GBP/month	Alpha (a), Programme Y Deficit, Total Fund Rate to be Allocated to Programmes, Sufficient funds for Allocation to Programme X and Programme Y	Actual Allocation, Inflows Y	Determines rate of allocation of collective funds to Programme Y based on relative proportion of the deficit of funds between Programme Y and Programme X
33	Rate of Allocation of Collective Funds to Programme X	Auxiliary	IF THEN ELSE (Sufficient funds for Allocation to Programme X and Programme Y = 1, Programme X Deficit, Total Fund Rate to be Allocated to Programmes * Alpha (a))	GBP/month	Alpha (a), Programme X Deficit, Total Fund Rate to be Allocated to Programmes, Sufficient funds for Allocation to Programme X and Programme Y	Actual Allocation, Inflows X	Determines rate of allocation of collective funds to Programme X based on relative proportion of the deficit of funds between Programme Y and Programme X
34	Alpha (a)	Auxiliary with Look Up	Alpha Min + (Alpha (hat) * (Alpha Max - Alpha Min))	Dimensionless	Alpha (hat), Alpha Max, Alpha Min	Rate of Allocation of Collective Funds to Programme Y, Rate of Allocation of Collective Funds to Programme X	Determines the proportion of collective funds that should be allocated between Programme Y and Programme X
35	Rho (p)	Auxiliary	Programme X Deficit / (Programme X Deficit + Programme Y Deficit)	Dimensionless	Programme Y Deficit, Programme X Deficit	Alpha (hat)	Proportion of Programme X deficit in relation to total programmatic deficit (of both Programme Y and Programme X)
36	Alpha (hat)	Auxiliary	Rho (p)	Dimensionless	Rho (p)	Rate of Allocation of Collective Funds to Programme Y, Rate of Allocation of Collective Funds to Programme X	As above
37	Alpha Max	Auxiliary	MIN (Total Fund Rate to be Allocated to Programme's, Programme X Requirements) / Total Fund Rate to be Allocated to Programmes	Dimensionless	Programme X Requirements, Total Fund Rate to be Allocated to Programmes	Alpha (a)	Determines the upper limit for the proportion of allocation of collective funds to Programme X and Programme Y
38	Alpha Min	Auxiliary	MIN (Total Fund Rate to be Allocated to Programmes, Programme Y Requirements) / Total Fund Rate to be Allocated to Programmes	Dimensionless	Programme Y Requirements, Total Fund Rate to be Allocated to Programmes	Alpha (a)	Determines the lower limit for the proportion of allocation of collective funds to Programme X and Programme Y
39	Programme Y Requirements	Auxiliary	RANDOM NORMAL (lower limit = 1, upper limit = 2000, mean = 1000, sigma = 10, 1)	GBP/month	None	Alpha Min, Outflows Y, Programme Y Deficit	Random normal function generates the GBP requirements per month for Programme Y

Ref No.	Variable Name	Variable Type	Algebraic Equation	Unit	Causes (other variables that influence this variable)	Uses (other variables that are influenced by this variable)	Description
40	Programme X Requirements	Auxiliary	RANDOM NORMAL (lower limit = 1, upper limit = 1000, mean = 150, sigma = 100, 1)	GBP/month	None	Alpha Max, Outflows X, Programme X Deficit	Random normal function generates the GBP requirements per month for Programme X
41	Programme Y Deficit	Auxiliary	IF THEN ELSE (Programme Y Requirements - Rate of Allocation of Earmarked Funds Programme Y >=0 , Programme Y Requirements - Rate of Allocation of Earmarked Funds Programme Y, 0)	GBP/month	Programme Y Requirements, Rate of Allocation of Earmarked Funds - Programme Y	Rho (p), Rate of Allocation of Collective Funds to Programme Y, Sufficient funds for Allocation to Programme X and Programme Y	Determines Programme Y deficit based on the difference between Programme Y requirements and funds earmarked funds for Programme Y
42	Programme X Deficit	Auxiliary	IF THEN ELSE (Programme X Requirements - Rate of Allocation of Earmarked Funds Programme X >=0 , Programme X Requirements - Rate of Allocation of Earmarked Funds Programme X, 0)	GBP/month	Programme X Requirements, Rate of Allocation of Earmarked Funds - Programme X	Rho (p), Rate of Allocation of Collective Funds to Programme X, Sufficient funds for Allocation to Programme X and Programme Y	Determines Programme X deficit based on the difference between Programme X requirements and funds earmarked funds for Programme X
43	Sufficient funds for Allocation to Programme X and Programme Y	Auxiliary	IF THEN ELSE (Programme X Deficit + Programme Y Deficit <= Total Fund Rate to be Allocated to Programmes, 1, 0)	Dimensionless	Programme Y Deficit, Programme X Deficit, Total Fund Rate to be Allocated to Programmes	Rate of Allocation of Collective Funds to Programme Y, Rate of Allocation of Collective Funds to Programme X	A decision rule that returns 1 of there are sufficient funds to meet both Programme Y and Programme X requirements or 0 if the funds are insufficient
44	Rate of Allocation of Earmarked Funds - Programme Y	Auxiliary	Funds Earmarked for Programme Y	GBP/month	Funds Earmarked for Programme Y	Inflows Y, Programme Y Deficit	Determines the rate of funds available earmarked for Programme Y per month
45	Rate of Allocation of Earmarked Funds - Programme X	Auxiliary	Funds Earmarked for Programme X	GBP/month	Funds Earmarked for Programme X	Inflows X, Programme X Deficit	Determines the rate of funds available earmarked for Programme X per month
46	Inflows Y	Auxiliary	Rate of Allocation of Collective Funds to Programme Y + Rate of Allocation of Earmarked Funds Programme Y	GBP/month	Rate of Allocation of Collective Funds to Programme Y, Rate of Allocation of Earmarked Funds Programme Y	Cumulative Funds Available Programme Y	Sum of funds available for collective allocation for Programme Y and earmarked funds for Programme Y
47	Cumulative Funds Available Programme Y	Level	Inflows Y - Outflows Y *(with an initial value of 100)*	GBP	Cumulative Funds Available Programme Y, Inflows Y, Outflows Y	Programme Y Reserves	The actual amount of GBP available at a point in time for allocation to Programme Y
48	Outflows Y	Auxiliary	Programme Y Requirements	GBP/month	Programme Y Requirements	Cumulative Funds Available Programme Y, Programme Y Reserves	The monthly amount that is actually allocated to Programme Y
49	Programme Y Reserves	Auxiliary	Cumulative Funds Available Programme Y / Outflows Y	Month	Cumulative Funds Available Programme Y, Outflows Y	Performance of Programme Y	The actual number of months reserve for Programme Y
50	Performance of Programme Y	Auxiliary	(Programme Y Reserves - Desired Programme Reserves) / (MAX (Desired Programme Reserves, Programme Y Reserves))	Dimensionless	Desired Programme Reserves, Programme Y Reserves	Performance against Strategy	The extent to which funds available for Programme Y meet the programme's requirements.
51	Desired Programme Reserves	Constant	2	Month	None	Performance of Programme Y, Performance of Programme X	Number of months of required reserves for each Programme as per policy

Ref No.	Variable Name	Variable Type	Algebraic Equation	Unit	Causes (other variables that influence this variable)	Uses (other variables that are influenced by this variable)	Description
52	Inflows X	Auxiliary	Rate of Allocation of Collective Funds to Programme X + Rate of Allocation of Earmarked Funds Programme X	GBP/month	Rate of Allocation of Collective Funds to Programme X, Rate of Allocation of Earmarked Funds Programme X	Cumulative Funds Available Programme X	Sum of funds available for collective allocation for Programme X and earmarked funds for Programme X
53	Cumulative Funds Available Programme X	Level	Inflows X - Outflows X *(with an initial value of 100)*	GBP	Cumulative Funds Available Programme X, Inflows X, Outflows X	Programme X Reserves	The actual amount of GBP available at a point in time for allocation to Programme X
54	Outflows X	Auxiliary	Programme X Requirements	GBP/month	Programme X Requirements	Cumulative Funds Available Programme X, Programme X Reserves	The monthly amount that is actually allocated to Programme X
55	Programme X Reserves	Auxiliary	Cumulative Funds Available Programme X / Outflows X	Month	Cumulative Funds Available Programme X, Outflows X	Performance of Programme X	The actual number of months reserve for Programme X
56	Performance of Programme X	Auxiliary	(Programme X Reserves - Desired Programme Reserves) / (MAX (Desired Programme Reserves, Programme X Reserves))	Dimensionless	Desired Programme Reserves, Programme X Reserves	Performance against Strategy	The extent to which funds available for Programme X meet the programme's requirements.
57	Performance against Strategy	Auxiliary	MIN(Performance of Programme X , Performance of Programme Y)	Dimensionless	Performance of Programme Y, Performance of Programme X	Effect of Performance of Strategy on Total Income	Overall performance against strategy is equated to the lower programmatic performance between Programme X and Programme Y
58	Delay Time	Constant	12	Month	None	Effect of Performance of Strategy on Total Income	The number of months delay that the effect of the performance of strategy has on total income
59	Effect of Performance of Strategy on Total Income	Auxiliary with Look Up	DELAY1I (Performance against Strategy, Delay Time, 0)	Dimensionless	Delay Time, Performance against Strategy	Total Federation Income - Mature Markets, Total Federation Income - Emerging Markets	Maps the effect of performance against strategy onto federation income in both mature and emerging markets